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ABSTRACT

This booklet is the thirteenth of a series of 16 booklets that together describe and present findings for a study which involved field observations and a survey of science teaching and learning in American public schools during the school year 1976-77. The study was undertaken to provide the National Science Foundation with a portrayal of current conditions in K-12 science classrooms to help make the Foundation's programs of support for science education consistent with national needs. Eleven high schools and their feeder schools were selected to provide a diverse and balanced group of case study sites. One field researcher was assigned to each site and instructed to find out what was happening and what was felt important in science (including mathematics and social science) programs. Findings from the case studies which pertain to the various aims of science education, the K-12 curriculum, and the question of pluralism and uniformity in science education are presented in this booklet. (HN)

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A project for the National Science Foundation
conducted by CIRCE and CCC
270 Education Building
University of Illinois at Urbana-Champaign

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Center for Instructional Research and Curriculum Evaluation
and
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The Project

Case Studies in Science Education is a collection of field observations of science teaching and learning in American public schools during the school year 1976-77. The study was undertaken to provide the National Science Foundation with a portrayal of current conditions in K-12 science classrooms to help make the foundation's programs of support for science education consistent with national needs. It was organized by a team of educational researchers at the University of Illinois.

Eleven high schools and their feeder schools were selected to provide a diverse and balanced group of sites: rural and urban; east, west, north and south; racially diverse; economically well-off and impoverished; constructing schools and closing schools; innovative and traditional. They were finally selected so that a researcher with ample relevant field experience could be placed at each. To confirm findings of the ethnographic case studies and to add special information, a national stratified-random-sample of about 4000 teachers, principals, curriculum supervisors, superintendents, parents, and senior class students were surveyed. Survey questions were based on observations at the eleven case-study sites.

The field researchers were instructed to find out what was happening, what was felt important, in science (including mathematics and social science) programs. On site from 4 to 15 weeks they were not required to coordinate their work with observers at other sites. Questions originally indicated important by the NSF or identified early in the field were "networked" by the Illinois team. Efforts to triangulate findings were assisted by reports of site visit teams.

Each observer prepared a case study report which was preserved intact as part of the final collection, and later augmented with cross-site conclusions by the Illinois team. The cost of the study was just under $300,000, taking 18 months actual time and about 6 research-person years to complete.

In the principal findings it was noted that each place was different in important ways, that each teacher made unique contributions. Nationally we found that science education was being given low priority, yielding to increasing emphasis on basic skills (reading and computation) Still, the JSSE-high-school science faculties worked hard to protect courses for the college bound, with many of these courses kept small by prerequisites and "tough" grading. Only occasional efforts were made to do more than "read about" science topics in most of the elementary schools. Although ninth-grade biology and eighth-grade general science flourished, general education aims for science instruction were not felt vital at any level. Seldom was science taught as scientific inquiry--all three subjects were presented as what experts had found to be true. School people and parents were supportive of what was chosen to be taught, complaining occasionally that it was not taught well enough. The textbook usually was seen as the authority on knowledge and the guide to learning. The teacher was seen to be the authority on both social and academic decorum. He or she worked hard to prepare youngsters for tests, subsequent instruction, and the value-orientations of adult life. Though relatively free to depart from district syllabus or community expectation, the teacher seldom exercised either freedom.

Each of the above statements is only partly correct. This summary is a drastic oversimplification of the circumstances observed by the field people and portrayed in the case study reports. The picture at each of the sites--seen through the experienced but singular eyes of our observer--is a special picture, greatly influenced by the administrators, the parents, and the students encountered; colored with technical, professional, economic and social problems. Somehow the pictures do not aggregate across sites to be either the picture of national education represented by the popular press (though no less aggrieved) or that presented in the professional education publication (though no less complicated). It is an interesting collection.

Robert E. Stake
Jack A. Easley, Jr.
Codirectors

LIST OF CASE STUDY SITES

	Code Name	Description	Field Observer
1	RIVER ACRES	a suburb of Houston	Terry Denny
2	FALL RIVER	a small city in Colorado	Mary Lee Smith
3	ALTE	a suburb of a large Midwestern city	Louis M. Smith
4	BRT	a consolidated district in rural Illinois	Alan Peshkin
5	URBANVILLE	a metropolitan community of the Pacific Northwest	Wayne W. Welch
6	PINE CITY	a rural community in Alabama	Rob Walker
7	WESTERN CITY	a small city in middle California	Rodolfo G. Serrano
8	COLUMBUS	the Columbus, Ohio, school district	James R. Sanders & Daniel L. Stufflebeam
9	ARCHIPOLIS	an Eastern middle seaboard city	Jacquetta Hill-Burnett
10	VORTEX	a small city in Pennsylvania	Gordon Hoke
11	GREATER BOSTON	an urban section in metropolitan Boston	Rob Walker

CASE STUDIES IN SCIENCE EDUCATION--ROSTER

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Chapter 12

THE VARIOUS AIMS OF SCIENCE EDUCATION

Margaret S. Steffensen

Overall, in the sites we studied, science (in the sense of the disciplines of mathematics, the natural sciences, and social science inquiry) was seen as having a rather limited value for the student body at large. Providing a strong program of science through elementary school up to college admission for those students who will become the nation's future scientists was not found to be a high priority goal for school systems. However, the programs in physics, chemistry, and advanced mathematics, particularly for the brightest youngsters, were being protected tenaciously by teachers in those departments in most of the high schools.

In practical terms every child was expected to learn to compute arithmetically, to take a course in biology, and to know some basic geography and history. Many elementary teachers were encouraging the observation and study of natural and social environments, but few were meticulously developing conceptualizations. Some of the traditional high school science content was being introduced in junior high or even in a few elementary schools. There was little agreement (and little hope of agreement) as to what is essential as skill or knowledge--though a strong and vocal portion of teachers and others argued that a list of essentials should be established and set as requirements.

During junior high school, if it has not started earlier, a progressive segregation of students occurred. Some took pre-algebra, chemistry, and geometry courses. Other "fast learners" joined this accelerated group a year or two later. These courses opened the door to more advanced mathematics, physics, and the advanced placement courses--the pride of the high schools. The grooming of a corps of future technicians, engineers, doctors, nurses, and scientists began here--and apparently only an occasional voice raised the thought that such disciplines also have a usefulness for everyone.

Perhaps because the practical problems of maturation, health, and financial management are undeniable, biology and arithmetic were considered necessary exposure for all students. (Few were questioning traditional requirements, many were seeking additional skill--as opposed to subject matter--requirements.) Most science subjects were seen as needed only by subgroups of students, many of whom have highly specific goals. The intriguing and impressive efforts that some teachers were making to enrich this sparse general education goal were scattered, diffuse, and showed no signs of either congealing as an educational cause nor of gaining general support from the public. (This seems also to be the case in the universities and colleges.) In most places geography and history were required. Other social studies courses (some of which were scientifically oriented) were found to have little general support, the possible exception being psychology, an increasingly popular high school subject.

We heard about the pressures on science teaching and the lack of support for it during visits to different sites:

Site visitors (reacting to statement by teachers and parents):

I was amazed at the number of teachers who were not aware of the curricular developments of NSF and other groups.

Science department monetary resources continue to be cut back.

A RIVER ACRES Teacher:

A lot of our students drop out of chemistry . . . because they claim they can't handle it. I don't think the subject matter is that difficult. It's the background and not being able to adapt to the standards the chemistry teachers require.

A teacher at our rural trial site:

I don't think the average elementary school teacher is really prepared to teach science.

An URBANVILLE administrator:

I think there are other priorities that have pushed science out of the way. . . . In the last six or eight years, it's been reading that has been a top priority, because it's been a problem with the public.

In our national survey, we asked superintendents, junior high science supervisors, and parents of seniors how they felt about slow students taking science.

Slow-learners should not be required to take a science course in high school.

	Agree	Uncertain	Disagree	Total N Responding
Superintendents	7%	1%	92%	73
Jr. Hi Science Supervisors	6%	1%	93%	139
Parents of Seniors	25%	4%	71%	111

Clearly educators and most parents want all students to take some science, yet most were not supportive of changing the courses to fit those not bound for college.

There are, of course, many important aims of science and many important aims of science teachers. We begin the presentation of our findings from the eleven case study reports--amplified with site visitor team reports and tapes, and with national survey returns--by considering those various aims of science education.

UNDERSTANDING

Teachers of science, mathematics, and social studies informed us that they want their students to understand the subject-matter of those curricula. They meant that they wanted the students to become knowledgeable, able to read intelligently, ready to work through problems, prepared for the next learning experience. It was not only a matter of knowing the meanings of words and the relationships among concepts, knowing the steps to go through to work a problem, but also knowing what content and what problems belong to which field, that for example, an interest rate problem belongs to one domain and a trajectory problem to another, that these boxes and arrows belong to a computer-program flowchart and those boxes and arrows refer to a judicial process. They wanted the student to be able to do well on a test, whether the teacher's own quiz, a part of the state's educational assessment program, or an admissions test for college.

Test are public manifestations of understanding, but the more important to the teacher was whether or not in beginning a new assignment or in reciting in class the student shows to the teacher's personal satisfaction a comprehension of the topic.

Standards of personal satisfaction varied from teacher to teacher of course. And they varied among parents, just as among educational critics. The effort to set uniform standards of achievement had not progressed far. There were vast differences between what adults would accept as evidence that Johnnie understands science. Our observations of science programs in eleven sites did not tell us whether the children's understanding of science in these schools was excellent or poor--partly because this study was not directed at student achievement, but also because our standards were too subjective. What we have done is to report on the circumstances in these schools, e.g., that we have found the objective of "understanding" widely honored, conscientiously pursued, and regularly obstructed. The honoring, pursuing and obstructing are detailed not only in this section, but in all the pages to follow.

One aim of school programs is to share old understandings with new generations. Other aims are to prepare the students for later study, particularly in college; to prepare them for working; to acquaint them with the values of our society, particularly in the realm of the intellect. Our encounter with those aims is discussed in subsequent sections. In the following section we discuss the pursuit of understanding, particularly through the process of inquiry, ranging from more traditional inquiry (by readying textbook materials) to the efforts of curriculum reformers to make inquiry more parallel to the quest of a scientist on the frontier of knowledge, noting both aesthetics of the search and the cautiousness with which evidence is accepted or rejected. These are all part of inquiry, part of the search for understanding.

Inquiry. In 1957 Max Beberman and Herbert Vaughan were creating a version of high school mathematics (UICSM) in which ambiguity of symbol was removed and which could be built on a nonverbal awareness of patterns in number problems and sets-and-relations. In 1959 Gerald Zacharias, Francis Friedman and Gilbert Findlay organized a version of high school physics (PSSC) which postponed the traditional opening chapters on Newtonian physics to midcourse, and opened instead with an exploration of the structure of the universe, followed by an exploration of wave motion, chiefly in ripple tanks. The demand in each case was that students think about patterns involving quantities and come

to an understanding of fundamental principles rather than just concentrating on solving particular categories of problems. Thus opened the grand preparation for inquiry as an ethic in pre-college science education.

The general reaction to the idea and the materials developed in these two projects was that they were too demanding on students. A few teachers were enthusiastic, but the approach did not spread. Now, UICSM texts are out of print although "Pronumerals," "Frames," and other ideas they introduced continue to find a place in school math texts.* PSSC is still in print but was being used in only a very few high school physics classes in the eleven sites.

A science teacher at BRT, our rural Illinois high school, said (p 4:10):

> *I liked PSSC physics. You really didn't tell the kids anything. It was very inductive. With the group I had at a previous school it was very good. They were eight, bright, highly-motivated students. It's a risky text as to how much kids are going to get out of it. We decided here to go with something more traditional to try to reach a greater majority of kids. I've got useful ideas from those series. I still like the labs where you don't tell the kids what the answer is.*

In the opinion of many enthusiasts these programs were too demanding of teachers, requiring a rather drastic shift in ways of thinking about teaching as well as changes in teaching practice. Teachers told us that if students were to cope with these new textbooks and lab materials in the same way they coped with earlier courses in math and science (and in the same way previous students had coped) then only the very bright students would succeed. Students had ample acuity and spontaneity to see new patterns. They could adopt exploratory modes of thinking. But few teachers were confident they could make systematic inquirers of them. It took they said, a special kind of faith, a special patience, to draw out and refine what the traditions of schooling did not encourage. The early ideas met with too much resistence and early in the 1960s gave way to material-development based on other assumptions, e.g., Motion Geometry, Stretchers and Shrinkers, Project Physics. In various ways, however, some science educators tried to keep alive the idea of "inquiry" as an aim of science education.

"Inquiry teaching"--as contrasted with didactic, recitation, or discovery teaching --organizes its course work around the more important observations and questions students raise, stressing individual student follow-up and probes. Text readings and workbook exercises are subordinate to student search for understanding. One of the more important findings of this case study project was that, despite considerable contact with legacies of the NSF-sponsored curriculum projects and with inservice programs dedicated to the promotion of student inquiry, very little inquiry teaching was occurring in science, math, and social science in the eleven sites. Lessons typically were organized by teachers around printed or dittoed materials. Problems were worked by the students,

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*Suzanne Quick reported a similar impact on science textbooks in her dissertation, "Secondary Impacts of the Curriculum Reform Movement: A Longitudinal Study of the Incorporation of Innovations of the Curriculum Reform Movement into Commercially Developed Curriculum Programs" (Stanford University, 1977).

following the example set by the teacher, who helped out when an obstacle was met, but who gave little encouragement to go beyond the problem or to question an implication.

(To our surprise, many observers reported little traditional "teaching" in which a teacher explains something that he or she understands and that the students are trying to understand, asking questions to find out what they do not understand, etc.)

On those rare occasions when our observers saw a teacher and pupils engaged in mutual quest for understanding, it seemed to occur almost by accident (cf. Chapter 16, the first section). Many of the materials developed to promote inquiry in children (MACOS, ESS, Cuisenaire rods, geoboards, PSSC labs, BSCS lab guides, etc.) were still there in the schools, often in storage or stacked in corridors, seldom being used. And when we saw them used, the atmosphere was typically one of "doing something needed, producing something, getting an answer somebody wanted." So seemed the case with a BSCS classroom in FALL RIVER, Colorado (p 2:6).

The teacher we found at the secondary level was not a "model inquirer." He or she tended to ignore details of the discussion, of the materials or data, which did not lend themselves to the scheduled interpretation. The students and their parents were comfortable, we believe, with the idea that the lesson was not aimed at raising a creative challenge or promoting critical thinking--but for discovering what others have discovered, understanding what experts have come to accept as standard conceptualization or theory. (See for example the lesson on thigmotropism discussed in Chapter 16.)

When we examined the most general statements of educational objectives for these courses and these school districts we found words that implied that it was important for children to inquire into their world. The more explicit statements of objectives indicated that it was important for children to know what had been learned by others who had inquired into matters of the world. The teachers for the most part explained that it was important first to get the basic skills, the vocabulary, the study habits, the arithmetic facts and all. Then, later, one could spend time wisely in more abstract and unstructured endeavors. Most parents agreed with this pedagogical and curricular commitment. Most students did also. A nation wide "back to the basics" movement seemed in many ways directly opposed to student inquiry. It appeared to suppress inquiry by "making sure" that students have been informed of the facts that they will need, to reach previously selected conclusions. The educational goals for most students, especially in senior high school, seemed deliberately narrow--for reasons that appealed to many diverse groups, reasons that will be developed at length throughout the remainder of this report.

The informal aims of individual teachers seemed to be a quiet but strong counterforce to this narrowing. Almost every science teacher had strong ideas as to what should be included in the curriculum, as to how the basics should be defined, as to what kinds of inquiry were good for students--and these ideas were continuing to be the prime determinant of what went on in that teacher's classroom. Still the teacher did take note of district mandates and more explicit statements of objectives. The teacher was increasingly aware of what was covered on standardized examinations and assessments, and increasingly sensitized to the poor scoring of his/her own students. Most teachers believed that you should teach interpretations and even inquiry in all

classes in all the grades at the same time you taught the facts of knowledge and skill--as the following item from our national survey* shows:

> Some people urge a big push to teach reading skills and math facts alone at first. Other people say you need to teach lots of basic information while teaching the skills. Others say "teach analysis and even interpretation at the same time." What do you say?

26% of the 146 social studies supervisors responding said: "Teach the basic reading
36% of the 58 elementary school principals responding said: and math at first, the
57% of the 93 high school math teachers responding said: other things later."

14% of the 146 social studies supervisors responding said: "Teach basic skills and
15% of the 58 elementary school principals responding said: lots of content first,
17% of the 93 high school math teachers responding said: the other things later."

38% of the 146 social studies supervisors responding said: "Teach all those things
45% of the 58 elementary school principals responding said: together, all the time,
20% of the 93 high school math teachers responding said: in every grade."

A few teachers, in ARCHIPOLIS and BRT schools, for example, were forthright in their effort to encourage inquiry. In one school one of our site team visitors saw a class in which students were actively engaged in inquiry, with the teacher outside the interaction. The teachers in those scenes testified though that it was very difficult, the results seemed to come so slowly, they never seemed to know just the right questions to raise. They stated they had to prepare so much more for inquiry lessons than for regular teaching that only a small percentage of time could be spent in inquiry teaching. (The reader would probably find the remarks of the teacher at BRT much more revealing of the complexities involved. They start on p 4:10.) So they too became persuaded that much of the inquiry will have to wait until "later."

Work or Play. Science, as seen by many of the early curriculum innovators has a strong aesthetic dimension. Somewhat in contrast is the rigorous craftmanship of the traditional view of science: formulate a hypothesis, deduce observable consequences from it, test the consequences, draw conclusions. Zacharias and Friedman contradicted the convention by emphasizing "hands on" manipulation, an approach at times almost playful. (Put two fingers into the ripple tank. Generate overlapping sets of waves. Change the frequency to see if you can recognize a pattern.) The little motors that gave precise control over wave generation appealed more to many teachers, but those around "Zach" caught his enthusiasm for getting their hands into it. Philosopher David Hawkins called it "messing about." They saw the sequence reversed; first you had to scuffle with nature to try to see what was happening; the precise control of variables with neat apparatus could come later. Good science education might not only be the pursuit of one's own curiosities, it might be a bit capricious --so the new ideas went.

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*Percentages are weighted according to the RTI sampling plan. Standard errors are given in Chapter 18.

Later David Bohm, University of London physicist, reflected a similar view with his notion of actions as creative processes.* Jean Piaget was rediscovered as having a theory of intelligence flowing out of human action. Thomas Kuhn's book, The Structure of Scientific Revolutions, stressed the irrational aspects of consensus within scientific communities and paradigms for interpreting phenomena rather than the rational aspects of building theory out of data.** Teachers in the fifties and sixties, especially secondary science teachers, were exposed to these new ideas. Many of the ideas were caught up into the promotion of "inquiry learning" and "discovery teaching." A great number of teachers were aware, and many were hopeful--but the universal realization was that with the way schools were then (and still apparently are) an inquiry approach would result in good learning and good test scores only with the bright youngsters from intellectually motivated families.

Inquiry does not appear to work. As indicated in Chapter 16 we found that many teachers feel that higher level study is hard work, life is full of hard work, the children need to learn that learning is hard work. It should be remembered that, the science experience of most high school teachers was largely confined to the rather rigorous, authoritarian undergraduate courses in colleges and universities.*** In a few places an undergraduate student majoring in science might work on a research project, and in a few instances the project might be one where creative inquiry was apparent. We found few teachers in the public schools we visited who had had that experience.

About 50% of our surveyed high school science teachers, 30% of our high school math teachers and 10% of the high school social studies teachers had attended at least one NSF summer or academic-year institute. In only a few of these institutes did the new "aesthetic" view prevail. They told us they read on the average about seven professional articles and four scholarly books a year, and some of these did raise the issues of aesthetics in science, math, and social studies. But the impact on the teachers's teaching was apparently small. Science was something teachers "took" in college, (often did well in), but it was not something they experienced as a process of inquiry, certainly seldom a personal participation in inquiry. It was not surprising then to find that creative inquiry was not what we found in these eleven high school science laboratories--except in rare instances.

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*David Bohm, "Physics and Perception," in The Special Theory of Relativity (New York: W. A. Benjamin, 1965).

**See both Thomas S. Kuhn, The Structure of Scientific Revolutions, 2d ed., enl. (Chicago: University of Chicago Press, 1970), and R. E. Ripple and U. N. Rockcastle, eds., Piaget Rediscovered (Ithaca, N. Y.: Cornell University School of Education, 1964).

***On the dogmatism of science teaching and textbooks see: Dorothy Nelkin, Science Textbook Controversies and the Politics of Equal Time (Cambridge: MIT Press, 1977).

Anthropologist Jacquie Hill-Burnett, one of our field observers recorded this in ARCHIPOLIS (Field notes):

> A sample full day was spent in Junior High, with one of the two science teachers in the school, a woman of much experience including a summer NSF institute. There was no doubt, from her own claim as well as the nearly dreamy nostalgic way she described the institute, that it was a peak experience of her life. Professor XX of West Virginia University had taught her, and others, not only about science but about inquiry. And she returned to her teaching setting so inspired that she stayed late into the evenings in her classroom allowing and encouraging students to come back to work on science, particularly laboratory projects. She used IPS a great deal then; now she uses it with only one or two classes. The enthusiasm for extra laboratory hours was suddenly stifled by an experience reflecting the danger in the environment. One morning her homeroom class saw in the school yard of the elementary school across from their school a dead man lying there, shot dead the night before. It shocked them, students and teachers, into the realization of the dangers they walked among, just getting back and forth to her evening classes.

It occurred to us that there was more reason to expect that real inquiry would occur in elementary school science classes. Many college courses on methods of teaching science in elementary school have actively demonstrated and encouraged student inquiry. So did many special workshops for elementary teachers and many of the summer institutes for elementary school science teachers. In fact, we heard high school teachers at our sites complain that

> *elementary teachers do not really teach science at all, they just teach how to observe.*

But we found little inquiry, little of the aesthetic view, little "messing about" in the elementary schools either. The problem here apparently was that many teachers, particularly in the upper elementary grades, did not feel they could afford to allow children to engage in such undisciplined, unproductive behavior. They were not somehow protected by the scientists, historians, and philosophers who testified that--even ideally--science was actually not so rigorous and disciplined, certainly not as much so as presented in textbooks and in university courses. Perhaps against the pressures of parents and teachers-up-the-line, these teachers felt obligated to more work-like activities.

As it became apparent outside the classroom, even a national embarrassment, that many children were not learning very much in school, teachers looked for ways of improving the performances of the poorer learners. The words "structure" and "structured" became frequently used to describe what teachers felt was needed. These terms usually referred to the directions teachers (or the authors of materials) gave for students to follow. It turned out to be a "persuasive" definition. But interestingly, it countered Piaget's use of the term "structure" to describe the developing organization of ideas in children as they manipulated objects in their environment. Piaget's observations that "structure is natural" were interpreted to mean that "structure is necessary", and researchers discovered that certain children lack the "structures necessary for learning science" and presumably, have to be "given structure" or "taught structure" so they can learn. Realization that knowledge is structured, that good teaching can be

structured, and that cognition is structured probably does not justify the belief that learning activities should be more structured than they have been, that they should be less open and aesthetic, or that they should postpone inquiry until certain prerequisite structures are in place. But we found the anti-inquiry work-ethic belief in "structure widespread.*

Empiricism. We found little reason to believe that school science teaching aims to develop an appetite for submitting beliefs to empirical test. An overriding concern in most science instruction was for students to arrive at the "right" conclusions. Getting there may have been primarily due to the charisma of the teacher, or to the faith of the student in science, or to something else. Interviews by CSSE staff member Jack Easley revealed repeatedly that students were tuned to pick up the cues teachers gave as to what was the right answer and that teachers were strongly bent on sharing the factual information, definitions, or general principles taught earlier to them.

Most science teachers felt that the emphasis on facts and techniques has been about right. Junior and senior high school social studies teachers tended to say that there has been too much emphasis on facts, not enough on concepts. But parents tended to say just the opposite (see Scenario Y later in this chapter) opting for a greater emphasis on teaching the facts.

At ALTE, a prestigious suburban high school, we observed several teachers pointed out as highly qualified by the principal and department heads. It was clear that they carefully planned and used data and arguments to support "the accepted theory." Never once did anything that would support alternative theories get a nod. (In social studies classes non-standard or unpopular views sometimes did get acknowledgement.) These excellent teachers were explicit in their teaching that science is tentative, that the scientist is ever a skeptic, that evidence rather than faith is the basis for knowing. But, just as the elementary teachers mentioned earlier, there was so much to get done; one usually must hasten past the doubts, the options, the weakness of the evidence.

We talked to students and found that doubts were there, even in those who had the greatest understanding, even among those who had the greatest inclination to accept whatever the teacher said. Would it be possible for science to be taught so that their own powers of inquiry would be more effective against the doubts? Did we pick up any clues about that? Not directly, but we connected a growing point of epistemological thought with the frustration expressed by some students, namely that science was too abstract, too contrary to intuition, too irrelevant to life's problems. (An URBANVILLE youngster wanting to become a ski instructor couldn't think of any reason why he should

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*This instructional structuralism appears not to generate more fundamental opposition to scientific inquiry than the various religious and spiritual movements which traditionally have opposed it. See, for example, Edward Shils, "Faith, Utility, and the Legitimacy of Science," in Science and Its Public: The Changing Relationship, ed. Gerald Holton and William A. Blanpied, Boston Studies in the Philosophy of Science, vol. 33 (Dordrecht, Holland: D. Reidel Publishing Co., 1976). Theodore Roszak's "The Monster and the Titan: Science, Knowledge, and Gnosis," Ibid; & Gerald Holton's "On Being Caught Between Dionysians and Apollonians," Ibid. "This kind of resistance does not go far enough to solve the problems of a future safe from the perils of technology," said Don K. Price, former president of AAAS.

take physics.) Based on the work of Piaget, Bohm, and others, the view is that new knowledge and learning is fundamentally based more on a mixture of action, personal experience, and old knowledge than on a correction of old knowledge by new information.

Propositional evidence presented to support a conclusion is less convincing to a dedicated scientist or a tenth-grade biology student than action performed by themselves to generate understanding of the conclusion. Scientific conclusions and personal understandings of science were apparently often considered implausible by students, not because of any evidence against them, but because the student cannot imagine or carry out the active process postulated. Classic examples of phenomena difficult for students to comprehend as actual mechanisms or processes include evolution (How can the missing links all have been adaptive?), and chemical equilibrium (How do you get ratios of concentrations from an image of a molecule separating and joining again?) Do lessons on these phenomena mainly teach that one must accept science on faith, that there is no personal action by which the scientist or student can verify the propositions?

The scientist, teacher or author who presents the principles of such concepts as believable because of the evidence for them is not involving the student in the evidentiary, empirical process, but simply giving assurance that the authorities are checking on the evidence. The models, images, and gestures used to understand these concepts appear to lack the generality of the principles and the evidence: they are idiosyncratic. They are often atypical cases and models which, by logical processes, have no persuasive power. However, the psychological power of actions to persuade belief is great, indeed almost too great for action models to be trusted; contrary models and mechanisms can be imagined with equally persuasive consequences. Yet the history of science is sprinkled with periods when it was only a kind of intuitive feeling for a model or mechanism that "held the fort" for an innovative theory until the data could be marshalled to support it. Unfortunately, this approach seems to be out of reach for most teachers--it flies in the face of scientific tradition. CBA Chemistry, which was one of the few serious efforts to communicate the images of models (though not much process of the action sort) is considered much less scientific and harder to teach than CHEMS. That is the way it is.

As we discussed these observations with professors and supervisors of teachers of science we found interest, hope, and despair. "If only science teachers knew more science!" "If teachers were only better at inquiry themselves!" "If they only accepted evolution for its factual support and explanatory power instead of as authoritarian dogma!" Such off-the-cuff reactions, however, failed to touch the reality of the life of a teacher in the classroom. In VORTEX Pennsylvania a curriculum coordinator said (p 10:10):

> *Teachers are experiencing difficulty with the inquiry approach--and we simply don't realize what it means when we suggest to an instructor that she needs to change her classroom practices."*

As we saw it, teachers and students were caught between parents and scientists. There was much on which they agree, but much on which they disagree. Teachers could not confront too many at a time. Some expected bad reaction in class if they admit personal or epistemological fallibility. They sensed antagonism from pupils pressured to have "the answer." They cling to their social rank, their podia, their seats of judgment. To give up their authority, to give way to "nature," to honor the pupil who has a profound but contrary thought, or to accede to the antagonized parent would be to lose the larger battle for the socialization of their pupils, to lose the respect of their colleagues, and perhaps even to lose control of the classroom.

An inquiry component to a curriculum would continue to be welcomed by some teachers. Action-based or process models of scientific concepts will continue to be appreciated by some students. They need to be assured that the evidence will be presented competently, that the inquiry and the activity do not leave the understanding of the phenomenon an oversimplification; that the activity has merit more than its power to amuse. Teachers are delighted to have student interest, but the teacher must feel comfortable with the admonition, "This is good for you--do it."

The aim of some science instruction is to make youngsters more self-sufficient in their inquiries into science. That aim was getting low priority in the schools we visited. There was a reliance on authority, a need for locating that authority in teachers and the school system. As a pedagogical device, that role of authority does little harm to scientific inquiry. The rejection of aesthetics and personal empiricism may be doing more to subvert inquiry as an aim of science education in the schools.

A Vignette of Inquiry. The ideal of the inquiring student, ruminating, probing, checking the alternatives, stretching his/her mind is inspiring--the actuality is likely to be chaotic and tiring. The youngsters do not put aside their personal feelings and social proclivities in order to ponder. They "mess about" with questions like "Who are going steady?" and "Who bought that new pair of skis?" Helen Simons, a site visitor brought in the following report of a Peas and Particles lesson from E.S.S.

> . . .Each group had one or two pictures of a batch--of nails, fish cans, people, etc.--and a short list of questions or each. The teacher was sitting with one group engrossed in their problem. I joined a second group of 3 girls and 1 boy. Their first picture was rows of fish. Their first question: Was it a day's catch or a week's catch? The boy was vigorously counting the fish one by one.
>
> They did not concentrate for very long on anyone's suggestion. They often did not listen to each other, repeatedly asking for the question and reasoning of the others to be stated again. (The girls giggling suggested that they may have been distracted by my presence at first, although later they spoke to me as a member of the group.) The boy seemed put out by the tape recorder. The girls indicated that he always fooled around. They were irritated at having him in their group and occasionally spoke very sharply to him indicating that he had not been listening and was holding them up. Five minutes before the lesson ended they got angry, "If you don't help us. . ." "If you're talking then you're not going to get anywhere." As the girls tried to reason out the fish question, he kept trying to be heard. When not listened to, he would offer his own idea, counting over the top of their voices or guessing. The girls were not actually solving the problem collectively either. Each was simply offering her thoughts on the question. After a few minutes of observing, guessing and counting, the girls decided on the first answer: a day's catch.

They then hurried to the next question: How many fish are caught in one week? The boy started counting. One of the girls started also. Both got to seven when a second girl (one of the advanced group) offered a solution:

> *Seven times how many fish. Just count the one row. Count one row at a time and seven times how many in that one row.*

The first girl said, "That's it". But the boy pointed out that the picture cuts off and there were more over at the far corner of the picture. Second girl again, "You could count two more for right here," (pointing to where the picture fades away).

Third girl starts counting, "1 2 3 4. . . ."

First girl interrupts, "No, not there, right here in this row because you can see this whole row."

Boy continues counting. . . .gets to 19. . . .

Second girl ignoring him, "Some of them are close together. You've got to count all the fish."

Boy still counting one by one. Now at 36.

Girl 2 murmuring, "How can we be sure. . . .that's what I'm saying. . . . better count them all." At this point the first girl says, "Let's make an estimate. . . . I think it's about a hundred." Then she modifys it to 65. The boy says 70; another girl immediately 71, a third 97. For the next few seconds they argue over the estimate. The second girl taking the initiative in deciding that 100 should be multiplied by 4 (since there are 4 rows) to give the number of fish in one day and by 7 to give the number of fish in one week: 2,800. The others rather desultorily try to check out that answer. They don't seem convinced but let it stand.

They start to solve the next question: How many pounds do the fish weigh? by guessing how many pounds one fish would weigh compared to one they are familiar with. They argue between 3, 4, 5, 6 pounds, each trying to assert his/her approximation as the one to go by. Eventually the first girl concludes that they weigh 8,400 pounds. She has taken the second girl's estimate of 3 pounds (dismissing her own of 5 pounds) and multiplied the number of fish in one week, 2,900, by 3. The second girl asks if she is sure, checks the answer. Third girl says that she checked it too. All write down 8,400. First girl says, "That's nice," with satisfaction; second, "What's next?"

The second girl to speak is most assertive throughout. She is also the most thorough, insists on checking before leaving the problem and more often than not comes up with an alternative way of looking at the problem. The others accept her decisions.

They move on to a new picture: paint cans on shelves in a shop; the question: Can the size of the paint can help you estimate the total number on the shelf? Their solution starts negatively. They seemed tired. (It is approximately 25 minutes into the lesson.)

Girl 2: *Let's just put no.*

Girl 1: *Yes. How many?*

Girl 2: *No, they can't.*

Girl 3: *No, I don't think so.*

Boy: *She wouldn't have asked that question unless it was on a theme. (He starts counting.) 1,2,3,4,5, 6,7,8,9,10. . . .*

The girls don't seem interested in this problem. They contradict whatever the boy says. He goes on counting. Gets to 20. First girl says, "I don't understand this at all." Boy continues counting to 42. . . girls giggle and laugh. Boy concludes of one shelf, "This is 40." "No, it isn't," says the second girl impatiently. Then she suggests, "Let's estimate." He retorts, "Let's just count." "O.K.," says the first girl.

Second girl says, "Oh. . .oh! there's a fat can here. . ."

Third girl by this time is also counting. . . .27. . . .30. . . .38. Everyone is counting!

Second girl exclaims, "Ha Ha! there's 38."

First girl repeats, "I don't understand this," and appeals to me for help.

I was reluctant to intervene as I was interested in seeing if they would get beyond counting. But they had shared their difficulties and were obviously frustrated. I said that I was just wondering if there was another way to do it. . . maybe instead of counting. . .

Two minutes later the teacher comes over to tell us that the group she is with came out with "something really great" which she says they will tell us about in five minutes. I feel I should have helped this group further. The second girl responds to the proposed ending of the lesson by pushing for an answer to the paint can question. But by this time the teacher's voice is dominating all the groups who are talking at once and this group fragments, leaving the first and second girl struggling. They decide as they had before that estimating is easier than counting. But they have not answered how or why.

Fifteen minutes before the end of the lesson proper, the teacher assembles the groups around the blackboard for each to share how they solved their problem. She encourages them to talk through their difficulties by first admitting a mistake the group she was with had made, "We made a big generalization which we found

did not work." She followed up with, "Whatever you found out, let's hear it, whether it was a success or not. We don't care."

She asks John to share his group's problem first. John is one of the brightest and one of her favorites. She commented to me afterwards that he never leaves school before saying goodnight to her personally. "He's the only one in the whole class who does that. I told his mother. . . it's so cute of him. He's such a darling kid." Not so darling according to some of his classmates. (Some report, "He doesn't control his arrogance," though they acknowledge his "brilliance.")

John's picture was the mass of nails He offers his explanation in a very confident manner. The teacher keeps interrupring to ask clarificatory questions, opening the process up for the rest of the class to follow. What he did was to take a small square piece of paper and place it in the middle left hand side of the large picture. He said he did not know how big the square was in answer to the teacher's question, but he measured that there were 100 nails inside the square. Then he placed the square over the rest of the page and found 367. He then multiplied 367 X 367. The teacher summarized: "You counted the number of nails in this direction and the number of nails in the other direction and multiplied one by the other. Now what did you get?"

"134,629," he announces. The teacher suggests they round that up to 135,000 and then asks what method of measuring he had used.

. . .

Later the observer commented:

Two things in particular puzzled me about the lesson: John's use of quantitative analysis and the students' understanding of the processes they or the other group used, or might have used. I did not hear the student who spoke before John mention the term quantitative analysis. I assumed that the class must have been taught this (and some understanding of the other processes) before, or John had special mathematical tutoring.

When I asked the teacher afterwards what knowledge the class had of the methods of measuring and what introduction she had given she said:

> *"Nothing. They did not know anything about it except that I just put volume on the board. . . I didn't tell them. . . they just figured it out. . ."*

Then she qualified:

> *"Well, they know what a binary is. . . well, some of them know about volume. . . and we work with weights. . . they know about quantitative. . . we work with analysis. . . and solutions."*

> She went on to say that when they had finished the unit they would know about measuring, volume, area, mass, sampling, ratio. She also said that it was the first time she had worked with E.G.G. and she was experimenting with it. She intended to try it again, integrate what was best into her own approach and leave the rest.*

It is easy to see how many teachers prefer to have children learn about making estimates by reading about how an experienced estimator would do it or the principal steps one should take in estimating. They of course may be right.

*Further comment on this vignette is on p 16:17.

COLLEGE PREPARATION

> Overall, Tony, a GREATER BOSTON senior, feels there are a lot of opportunities for students at the school, but that you have to push to get them. Through the flexible campus scheme he is taking a calculus course at a nearby State University, but he says he had to keep reminding people at school about the course in order to get in. "At my last school there were about twenty counselors, and they kept at you all the time to get college applications in. It was a school where most students went to college and the school was all geared up for it. Here there are only three or four counselors and most people are very busy. It means you have to do a lot of things for yourself" (p 11:39).

In GREATER BOSTON we found the high schools oriented more to the colleges than to any other institution or enterprise, just as the junior high schools were oriented to the senior highs, and the elementary schools to the junior highs. We did not find a high degree of articulation (see Chapter 14) or a strong sense of course sequentiality, but the teachers thought of education to a great extent in terms of their own experience (consider Mr. L., a long-time math teacher at rural BRT, p 4:27) and, of course, college was so important to them. The strong orientation to college was true even for schools such as this one in GREATER BOSTON where fewer than half of the youngsters would go on to college.

A Preparation Ethic. The purposiveness of the schools, upon close examination, did not seem to be simple, well-focused, or well-coordinated. Its roundness and tentativeness was very much in tune with the nature of the youngsters there, and with the sensitivities of the teachers, for they knew that most youngsters would not be settling into life-work or even social commitments until they reached the middle twenties. This distressed many parents, who knew that there is so much to know, so much preparation needed for a successful professional career. It distressed many administrators who would like to organize instruction in the most rational fashion, where purposes were explicit and progress toward those purposes properly quantified.

A considerable rhetoric of purpose thus emerged--statements of goals, criterion referenced testing, career planning exercises, counseling, accountability--all of which related to the responsibility of the schools to provide maximum service to students and taxpayers, but which was frustrated by the fact that young people do not know what they will need, nor do more experienced adults. The kind of education that is most appreciated anywhere is never easily explicated. (Even with the purposes the schools do have, the most suitable methods of attaining them are seldom clear.) What we had then was an institution that wanted to be purposive and efficient, but which was more a holding pattern than factory, keeping youngsters safe, increasingly encumbered with "responsibility" and exposed to the ways of the dominant society during childhood and early adolescence.

Perhaps the most frustrating aspect to this was that some of the children were not learning to read and write, not only at levels admired by college professors and social critics, but at levels they and their parents had come to believe were guaranteed by the district. (They have come to believe it because educators and politicians

have promised it.) Thus the rhetoric of the schools in recent years stressed the purposes of gaining minimum competence for all youngsters, not as a response to, but simultaneously and in concert with the public yearning for a return to the "basics."

The formal talk was about the basics, about minimum proficiencies, but the informal talk, and much more of the striving, in the schools continued largely to be oriented to college preparation, or preparation for something likely to come. Certainly, eighth grade is likely to come after seventh, so there was a great deal of talk about getting ready for what the eighth grade teachers were going to insist on. Since students and teachers were moving around quite a bit and there had not been a great deal of uniformity across classrooms, there was not much actual structuring or constraint on the immediate studies. Course work could be pretty much what the teacher believed was best for the youngsters at the time--but the talk was there. This responsibility to socialize the youngsters to purposiveness, to preparation, to work, and to rationality is discussed at length in Chapter 16.

The most vivid statement about "a preparation ethic" was written by Terry Denny in his RIVER ACRES, Texas case study. The section (p 1:13) closed with:

> That mathematics teacher spoke for many, many others in the sciences and social studies as well. She works hard at trying to prepare her students and by her own admission is not making progress as the years go by. It is a hit and miss proposition. But the target is clear. In RIVER ACRES the junior high school curriculum arrow points in one direction: to Central High School. What the students have been getting ready for is variously described as "the big crunch, algebra"; "where many of the Latin [Mexican-American] students will meet their Alamo"; "the Rites of Academic Passage [re college]"; and "the end of preparation and the beginning of the real thing."

Responding to our national survey (reported on p 14:31f) junior high teachers were strong in their endorsement of preparing for the year ahead, somewhat more so than elementary school mathematics supervisors. (This orientation may be partly due to the fact that many junior high teachers were trained to teach at the secondary level.)

The College-Bound. Tammy, a junior at BRT told observer Alan Peshkin (p 4:49):

> *Next year I'll take sociology and psychology. I need them because they're useful for being a psychiatric nurse. Any course I take is for my own personal interest or for college.*

In all our CSSE schools those students who clearly were headed for college were provided with special courses in science and mathematics and sometimes social studies. Observer Mary Lee Smith reported on mathematics from FALL RIVER (p 2:10):

> Students follow three tracks. The most difficult consists of geometry, algebra II and trig, math analysis and advanced placement calculus.

Students not bound for college were not excluded, but the courses did not exist for them.

In several other CSSE high schools advanced placement courses were offered, entitling the student to special credit in college if the college was willing. At most colleges and universities it meant opportunity for the student to begin on a second or even third level in the sequence of such courses. The high schools were proud of these advanced placement courses and staffed them with some of their best teachers.

Gaining admission to college was not at all difficult, if the student was not particular about which college to attend. Failure to take or pass a certain required course could be made up by community college enrollment, available conveniently and relatively inexpensively to most youngsters living at home. Gaining admission to a prestigious or popular university was more difficult, even moreso to pick the area of major study at that school. If a subsequent enrollment in professional school was part of the plan, then parents and student may have fretted about the high school grade-point average.

At some schools maintaining a high grade-point average in high school and having a high school record which included several science courses was not easy to accomplish. According to our survey a third of the students and teachers thought it more difficult to get good grades in science than in other subjects. See BRT (p 4:5) for a description of a teacher who consciously made his science classes an exception to this trend.

Getting a good grade was the primary goal for many students who intended to go to the colleges of status and prestige. For some students the risk of getting a poor grade outweighed the potential value and interest of the content of science courses. The impact of grade consciousness was indicated in the field notes from observer Lou Smith regarding a biology teacher in ALTE (p 3:67):

> In recent years, a shift in kids from quantitative biology to general biology--four sections vs. six sections. Used to be the reverse. She attributes it to lower parent expectations and the fact that an able kid might get a 3 or 4 in general biology but only a 2 or 3 in quantitative biology. The kids want the higher grade average, regardless of learning, for the college admissions race.

Even students in the science courses seemed not so much attracted to the content as to the more certain prospects of admittance to colleges of status and prestige which required more high school science courses for admittance. The college bound students were extremely aware of the value of the grades and seemingly less aware of the value of the content in science courses. More discussion of grading is presented in Chapter 15.

A "prep school" attitude was common in schools like Hardy High in URBANVILLE where a majority of students go on to college. There the assumption was strong that the faculty was there to prepare their students for college. In a VORTEX site visit report (Weller):

> However, despite disclaimers to the contrary, City High is still a college preparatory school. The community expects it and the teachers and administrators still see themselves in the old image. Though teachers claim they have much freedom in what they can teach and how they teach it, they still orient their required courses toward academics to prepare students for college.

> For example, when I asked a chemistry teacher if she had any messages for the NSF, she said, "Survey the college chemistry professors to find out what they want us to cover in our high school courses." Or, a biology teacher commenting on what he teaches in Biology I, theoretically a required course: "We know what kids going to college are going to need in college." Or, an environmental science teacher: "Environmental science should be an elective, because kids going to college need basic biology as a prerequisite."

Parents supported this form of preparation (p 1:81):

> *The mid-sixties found chemistry looking more and more like physics. Our first-line chemistry course is loaded with mathematics. Some teachers want to change our second year chemistry course to emphasize oceanography for example. Parents say "no"; they need solid chemistry to get into and do well in college.*

Mr. L. had been teaching math in BRT for twenty-two years. He said (p 4:29):

> *What I like best about teaching is . . . when I get students who perform well, especially if they carry on beyond high school into college work.*

ELITISM

In the science departments, especially with those who teach physics and chemistry, and to a lesser extent in the math departments of the high schools, we found an aim to be the best. It was an effort to excel, to get the students to excel, to be the elite of the academics in that school and compared to other schools around. The drive carried with it that search for prestige, that inclination toward exclusivity, and even an expectation of special privilege, that is often associated with elitism. We did not find this among those who taught government, geography, psychology, perhaps a bit among those who taught history.

It seemed that this was not just an aim that accompanied the teaching of science and math, but even transcended it. The claim will be made in Chapter 16 that there were times when subject matter aims yielded to socialization aims as the purpose of the instruction. A teacher told us:

> *Elitist? Of course I'm elitist--I'm here to teach the elite of this school. If they disappear so do I and the physics class. You want to know why physics classes have gotten smaller in the past few years? It's because parents have become anti-science and they don't want their kids to be part of the science elite.*

Whether they approve or not, parents we met recognized the special drive for excellence and exclusivity. A parent of a college-bound youngster in FALL RIVER said (p 2:7):

> *I've been very disappointed with the district for watering down the courses. There used to be a really strong physics program [with PSSC], but then [the teacher] decided he needed to*

accommodate the low to middle achiever so he threw out the good program and came up with this other one that is less comprehensive. It really hurt the well-motivated kids.

And in URBANVILLE a parent of a youngster unlikely to go to school beyond high school said:

I think it would be all right if students didn't take any science at all at the high school level. . . . There are a lot of things kids are never going to use again.

Some teachers apparently helped encourage this attitude of exclusivity, intimating that science is not important for everyone because it is something that is not needed in the everyday course of events. Science is important for those who are going into technical or scientific careers, they implied. Many mathematics and science teachers added to this feeling by setting absolute standards of excellence or standards relative to what they learned in college or elsewhere rather than relative to what the students in their classes could and should do. Some say:

Science is tough. If you don't have the mental equipment, you won't be able to understand it.

This may be true, of course--but the message also was that it is all right for science to be exclusive, concerned primarily with the education of the more gifted or highly motivated students.

Questions 6-12 of Scenario Z of the national survey were drafted with attention to the issue of elitism in pre-college science instruction. The response indicated that teachers, counselors, and students saw much of the science program as college-oriented and saw some need for more science courses as general education. Details are reported on pages 13:15 and 18:81.

In most of the high schools we visited we found physics occupying the pinnacle of prestige among subject matter areas, with chemistry taking second place. Biology took a lower station, partly because of the greater commitment to general education, the need for providing the required course for graduation, and perhaps a greater concern for getting students ready for the biological responsibilities they will face in life.

In mathematics, Algebra I, geometry, and Algebra II were considered prestigious, with only the brightest enrolling in all of them. The high status of these courses was reflected by some parents "pushing" a child into them even though the teachers thought the child insufficiently able, interested or ready (see RIVER ACRES, p 1:79).

Elitist aims appeared to begin with instruction at the high school level, possibly some in the junior high. Science and mathematics were taught in elementary schools without the air of prestige and exclusivity. An elementary teacher spelled this out the opposite for science (p 1:35):

I feel science and social studies give us the one place in academic schooling where the lowest kid can really participate in class. There are so many things that can be done that are fun for children of all ages and abilities.

Children at this level seemed to share this teacher's view of science. In the lower grades it was a popular subject, even though not emphasized as much as language arts and arithmetic. In the upper grades, science became somewhat more formalized as a subject matter, no longer easily lumped together with the social studies, and less often considered "fun for children of all ages and abilities."

The social sciences did not occupy a position of prestige in the schools we visited. We found a disproportionate enrollment of students who were not academically strong and poorly motivated in the social science elective courses. (See a discussion of this in the BRT case study, p 4:39ff.)

Commonly occurring with an elitist view of instruction was the use of prerequisites and a mild form of tracking. By having more homogeneous grouping, the teacher said he/she could adapt the material more closely to the ability of the students. Heterogeneous classes were more difficult, sometimes even nearly impossible to instruct, the teachers believed--and we had little reason to doubt it (RIVER ACRES, p 1:89).

> *Mis-assignment is detrimental to my teaching. With the size of classes, mixing the levels would be disastrous. Teachers are human. We respond to students who listen to us and ignore the lazy and disruptive ones, even if that's unfair to them.*

The drive for homogeneity can be so strong that, once established, it continues to press on and on. In RIVER ACRES (p 1:61) we were told:

> *We all prefer four levels to three. The "bad-news fours" could [then] be isolated. Now they contaminate.*

The RIVER ACRES case study is an excellent source of views on tracking and grouping. Difficulties of teaching heterogeneous groups and a conflict between desires for ability grouping and desires for equal educational opportunity for all youngsters are discussed in Chapter 14 in this Booklet XII.

The seniority system common in these schools supported an elitist view of science instruction. The most experienced teachers migrated to the brightest students, while young and inexperienced teachers, those whose teaching preferences were last to be honored, were assigned to the least able. They were teaching where teaching was the most difficult and demanding, and where they were the least able to cope. A social studies teacher said (p 1:121):

> *A new teacher comes in, is all idealistic about these slow students. They have come out of these education courses where they are all idealistic about these students without realizing what they really are like, . . . what their home life is like. You've got to take that into consideration. I mean you can't expect a lot out of those students if you go and look at the homes they live in. No wonder they can't read. You see, you as a teacher can't change that. You've got to accept it. If you're going to help them, you help them before first grade.*

Setting aside the defeatism, the message about elitism of some classes, of some teaching, was clear. A new teacher working with lower level students in RIVER ACRES (p 1:117) said:

> *The lower level kids are almost never taught by the better teachers who have been here for three or more years. . . . By the time I get the experience I need, I won't be teaching the lower levels.*

The youngsters knew who the better teachers were, who the more prestigious teachers were. They knew which students were apportioned the best things the schools had to offer. Certainly it was not only the physics and Algebra II students--for the basketball team, the children of the well-to-do, the youngsters who liked to help teachers, and special others, were awarded special privilege too. Our observers could not but help admire those teachers who tried to get scholarship rewarded as highly as anything else, but could also not help but reflect how easy it was for the aim of excellence to become the aim of exclusivity, and to transcend the pursuit of knowledge and understanding.

VOCATIONAL PREPARATION

In addition to the search-for-understanding and preparation-for-college, science education aims to prepare youngsters for work--or at least for vocational training. For this aim, science is often closely identified with technology.

The preparation ethic discussed in the previous section is pertinent to what is said in this section too. For us there is a need to know the purpose of something. One visitor from Europe asked, "Why does it matter whether anyone uses long division?" And we may not have a good evidence, but we will have an answer. In the schools we studied there was a strong sense that what mattered most was what could be used in one's next studies, and that those, or the ones after those, were related to what one would be doing on a job.

This vocational orientation of science education is consistent with several ideologies. First science in secondary school is often seen as an elitist program intended not only for being the best in scholarship but the best in professional endeavor, e.g., engineering, medicine, actuarial science. Second, it reflects a pragmatic American culture, valuing what is essential for making a living, keeping one's possessions in good repair, etc. And another view links science with vocational preparation through an analytic epistemology, breaking down knowledge into its pieces; the facts, skills, procedures and components.* The elitist, pragmatic, and analytic somehow join forces to authenticate the study of science in the American schools as a proper vocational effort.

As we said above, what mattered most (in the eyes of the people we talked to) was what could be used in one's next studies, and that it ultimately would relate to work. But what mattered most did not necessarily matter enough. We found considerable resistance to the idea that science is preparation for work. In URBANVILLE, one high-schooler put it this way:

> *I feel to really help you make it in this crazy world of ours, you're going to need practical stuff--business, things like that. Like typing, that comes in handy all the time. I feel that if*

*One argument is that if knowledge is treated as a collection of pieces, rather than as ideas or models or metaphors, then the vocational relevance of courses can be controlled with the irrelevant pieces trimmed away, or never acquired in the first place.

more people take business classes, they'll do better; have a better opportunity. When you do get into higher math and science stuff, sometimes you feel unless you're really going to continue and be a physicist or something, there's no reason to take it because you're never going to use it. Unless you're really planning on climbing the ladder and be 'way up there. It's practical to stop.

This view was shared by many adults. The vocational motivation for studying science may be becoming more complex. Our observer in VORTEX, Gordon Hoke, reported (p 10:8):

> Interactions with students suggest that reasons for taking certain courses are changing--that is, math, science, and the social sciences are seen as tools for eventual careers or jobs in health and medical fields, in other realms of social service, as a means of understanding self and others, and not as a prelude to becoming a mathematician or scientist. The number of extra-curricular activities identified with social services is increasing and students are aware that for them the "services society" means jobs as well as higher taxes for their parents. A senior in chemistry noted: "We've started a medical/health careers club and have about fifty members. There's a lot of interest." In response to a second question, he responded: "Because of prestige, money and jobs."

Financial payoff was widely recognized as a motivation when choosing elective courses or in establishing the proper level of commitment to subject matter. Some students denigrated their teachers because they were poorly paid. A RIVER ACRES senior said his parents did not know the difference between Jacksonian and Jeffersonian democracy but they earned a lot more than his teacher (p 1:114); see BRT, p 4:4, for similar statements. The implication was of course that he did not need to know to succeed either.

Teachers recognized what they were up against:

> *Salaries, obviously they're going to be a big incentive to students and not many see it's going to pay them to spend the extra time studying science.*
>
> *I've taught social studies. The kids look on it as not really necessary. Even in U.S. History they ask what good it'd do [them] in making a living (p 4:4).*

Teachers felt the tug of these material ambitions personally. At the trade school in PINE CITY, we were told:

> *It's hard to see a boy that's been out of school two years and come back and show you pay stubs that would exceed yours on a monthly basis by 400 or 500 dollars.*

But the above were not the views of the majority of teachers, students and parents. It was much more common for us to hear a teacher speak with pride in his/her courses,

confident that they were relevant to the kind of thinking needed in vocational pursuits. One told us:

> *I push the kids more to take chemistry than I do to take physics because I think there are more vocational areas they might be interested in where they're going to need chemistry.*

It was common to find students who were satisfied that the vocational relevance of the courses was there, but not made very obvious to them. A young fellow named Dave in PINE CITY said (p 6: 38):

> *I knew by ninth grade I wanted to go into criminal justice so I found myself asking why biology? It's a question a lot of students ask themselves. Why science? And it's not a question that school really answers. I think teachers need to bring out the practical uses of the subject more. That would help . . . though I don't know to what extent.*

The fact that parents spoke highly of the vocational purpose of schooling should not be interpreted that they felt that it was not now so aimed. What they apparently wanted was a more effective course of study, not a different course of study. They had seen the youngsters of the community going into nursing, sales, office work, and they were reasonably comfortable that the things that were in the curriculum were vocationally relevant. What seemed to bother a great many was that too often the courses were not taught well enough to some youngsters to make them vocationally "ready" upon graduation.

Where the Jobs Are. The vocational definition of science has been influenced by the increasing relationship between industry and the school. Consider the following statements:

From a BFT parent:

> *We do not have a science background in this community because industry is not here.*

From a PINE CITY employer (p 6:47):

> *The right attitude to work is what we need, not specific training for the job. If industry gets people with the right attitude, we can teach people what they need to know, probably better than the schools, because we can teach them on the job.*

From a science coordinator at our urban trial site:

> *In February, March and April, people in the truck farming areas and the horticulture industry and so on are asking for young people to help them out onto the market. There always has been a demand, and we will be able to fill that demand with that speciality in agri-business during the demand period.*

The increase in vocation fields open to women was reflected in increased enrollments of women in math and the physical and biological sciences (see Chapter 15). One female student from PINE CITY said:

I know a lot of girls who are thinking of taking engineering in college. More of them are thinking about majoring in aero-space engineering. They're thinking more along that line of work now . . . than they have in the past.

In places where the feminist movement has not been strong, we noted a low enrollment of girls in science courses. The FALL RIVER physics teacher gave the following explanation of the 1 to 9 distribution in his class:

A lot of times girls do well in mathematics; this isn't what holds them up. They simply don't see physics in their career plans. They don't see it as a prerequisite to anything they plan to do.

The vocational emphasis on schooling was forcing parents, counselors and students to predict where the jobs were going to be so the student could jump into the courses that would have the highest payoff. One student who participated in the PINE CITY site visit explained:

There's a greater demand for medical technicians now, but the trend could change in a few years. It changes all the time. [The students] go from one area of study to the next, wherever the greatest demand is.

Prediction of employment possibilities demands information, and a pipeline has developed between high school students and their older peers, as we learned in FALL RIVER:

The younger kids pay attention when the college grad speaks. He goes out and can't get a job--they pay attention. Maybe they'll go to college, maybe they won't. He's disappointed with science--it really makes a total difference.

This results in a rapid feedback to the schools of what the job market is. It appeared to exert some long-range pressure on course scheduling as students enrolled in those courses which appeared to enhance their employment goals.

Many people (but not all) felt the school should be even better tuned to the job market. From RIVER ACRES we heard:

We don't spend enough time on career education. This is something that ought to be integrated into the subject matter. It's amazing how many people are graduating who really don't understand some of the jobs that are available.

The counseling provided by the school was often seen as inadequate by students who planned to enter the job market. College-bound students sometimes voiced the same complaint. From URBANVILLE, we heard that advice on college admissions is sometimes not available:

> *Most of us, as far as college plans are concerned, would really like to have a chance to sit down and talk with a counselor, but the counselors aren't there and there are too many kids.*

Often this failure to obtain counseling extended to course selection:

> *I think the opportunity is here for us to prepare ourselves for college, but some of the kids don't take advantage of it and some of us don't know what we're supposed to be taking advantage of. We're not sure of what we should be taking and what we should be leaving out.*

A number of teachers also felt that the counselors were providing no help in getting students in the right science course (see the comments of a FALL RIVER physics teacher, p 2:17). Even worse, in URBANVILLE occasionally a counselor was seen as steering a student away from science to easier courses in order to preserve his or her grade point average. We asked about this questionable advice in our national survey and were told that it is very rare for high school counselors to encourage students not to take science courses.

In RIVER ACRES one of the counselors' primary responsibilities was placing the students in tracks. While there was general agreement about who should go in the highest and lowest levels, there was a great deal of questioning about level two. There was essentially no empirical data on this group's performance (see p 1:72). A principal source of conflict in RIVER ACRES was the tendency of counselors to place students in a track without consultation with teachers or without regard for their recommendations (see pp 1:94, 1:100 and 1:195). There also was conflict between counselors and parents there over tracking and grading. Often a student would get a "C" in an accelerated course when he or she could have gotten an "A" in a level 2 course for the same performance. But overall, there was little doubt that the counselors were trying to do what was best--as they saw it--for the child.

Occasionally we heard about counselors routing students into the sciences, as in the following case (p 6:66):

> The business of counseling was number one or number two among the gripes of the physics teachers. On the other hand, at least one student from PINE CITY reported that her counselor had encouraged her to stick with chemistry when she wanted to give it up, a decision she subsequently felt was a good one.

As with teachers, we found some counselors strong and some weak. Most had heavy loads and were expected to deal more with in-school decisions and problems than with long range planning.

VALUES

Directly and indirectly, the science student is introduced to different role-models. He or she is encouraged to be more like the scientist, or the science teacher, or the ideal science student, who may from time to time appear quite different. On one occasion the ideal may be:

observing,
skeptical,
relativistic,
speculative, and
searching for the flaw in all previous thinking.

On another occasion the ideal may be:

precise,
objective,
analytic,
impersonal, and
searching for the definitive experiment.

And on still another occasion the ideal may be:

careful,
conforming,
anticipatory,
productive, and
searching for the answer to the problem.

Of course these are not pure types and the values taught young science students may come in any number of combinations. But one can recognize in various writings and teachings such archetypes as the grand thinker, the technical virtuoso, and the trustworthy subordinate. Students were beckoned by such ideals in many of their science classes.

It used to be more common to hear claims that science is value-free.* In our studies of eleven clusters of public schools we heard very few science teachers making such claims, though it was common to hear words from which it was easily inferred that the control of bias, the pursuit of value-free knowledge, and solution to value-laden problems could be facilitated by taking a scientific approach to the matter. No end has come to the teaching of the values of science as a contribution to thinking, problem-solving, and preparing for the tasks of life. But it was a relatively quiet evangelism in the CSSE schools.

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*For the counterclaim see Jacob Bronowsky, Science and Human Values (New York: Messner, 1956); and André Cournand, "The Code of the Scientist and its Relation to Ethics," Science, 18 November 1977, pp. 699-705.

It is clearly recognized today that many public controversies involve scientific topics. To name a few, there is the control of population growth, the teaching of evolution, debates over when the human embryo becomes a living person, the control of recombinant DNA research, the danger of nuclear power plants, and the diminishing ozone layer. Students recognized these as science topics. They were not able to, as the greatest mind is not able to, see the "bit of pure knowledge" as separate from that same knowledge in a social context. Students have learned that it is okay to snicker when anyone--and certainly a teacher--claims that science is value-free.

Rather it was commonly accepted that science has its values, and its involvement in controversial topics, and its lobbies in the houses of government. We did not find it to be a common topic of conversation. It was not that it had not been studied. It was just that the age of innocence had passed.* Youngsters and teachers, alike knew that scientists were human and science was political--but of course they admired some ways of behaving more than others, and many of the good ways they continued to associate with science and scholarship.

The qualities of the grand thinker, relativistic and speculative, were only occasionally acknowledged by teachers to be worth emulating, and often--removed from association with science or grand thinking--were ridiculed. The qualities of the laboratory technician, precise and analytic, were more frequently acknowledged by teachers to be what it takes to succeed in a scientific or professional career. But the qualities of the trustworthy subordinate, careful and productive, were urged upon students almost without interruption.

One would expect more opportunity in the social studies than in the natural sciences, and certainly more than in mathematics, to consider value-laden and controversial subject matter. But even in the social studies we did not find serious controversy over teacher presentations within the communities we visited. The handling of "taboo" topics was not one of the issues that concerned people we talked with. However, it became increasingly clear that teachers were strong advocates of "American values" in all three subject matter areas.

This effort to inculcate a set of values will be reported later in this chapter and again at length in Chapter 16. Though the data were seldom direct or systematically probed, this finding was later felt to be one of the most consistent of the CSSE case studies project.

As indicated four paragraphs back, the value-free claims of science were transformed partly into value-control claims, claims that the bias of ordinary perception can be controlled by reliance on scientific methods and science-tested knowledge. The control of bias would be mentioned when answering the question of why science is studied. That is not to suggest that it was often mentioned, but the reference was made. And it was most frequently encountered in the CSSE classrooms when the class was scheduled to deal with, or more frequently, stumbled upon, a controversial topic.

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*As had passed the shock that some of science's peacetime products were as potentially great a threat as its machines of war.

Controversial Topics. Most teachers were quite sensitive to, even if they did not personally hold, the dominant values of the community. They seemed, by and large, to find no problem in presenting their subject matter in ways that were acceptable to most local feelings.

There were at most two or three allusions to controversy over the treatment of controversial topics in the eleven case studies. Teachers interviewed seemed confident that they knew how to handle such subjects to avoid difficulty. For example, there were no "creationist" protests against the teaching of evolution in any of these schools. The biology teacher at BRT, a school in a conservative community, described her approach this way (p 4:11):

> *Evolution has never come up as an issue. I don't know. My personal view is probably close to safe because I don't see any divergence between the theory of evolution and a religious viewpoint. I suppose I'm not really radical. Maybe that's the reason I haven't had any feedback. If I were an atheist, I suppose that might present a problem. And the students don't make it a problematic discussion either. Never had anyone do that. Here again, our students are pretty much of one mind. They're pretty closed in the ideas they have. I've hardly had any feedback from the community.*

The same teacher went on to say:

> *Some places have had controversies over sex education. We teach it in health, and in biology when I go over the reproductive system I discuss contraception and venereal disease. We feel it's necessary for kids to know these things. We give it simply on an information basis. Most of the parents prefer that the kids get it here because a lot of them don't know much of this stuff. As long as you don't get into the moral aspect.*

In a district where there was no "approved reference book" on human sexuality (perhaps an influence of the predominantly Roman Catholic population) at least one teacher had spent his own money to buy such books for his class and had taught the subject to his students.

After observing in RIVER ACRES Terry Denny wrote (p 1:53):

> The only junior high school social studies teacher in the district that I saw approaching what could be called a controversial topic had this to say after class:
>
> > *The teaching of man's relation to himself and others necessarily brings up religious, political, sexual, ethnic, racial problems and deals with very touchy subjects because of what shall we say, the Bible Belt?. . . If you mention certain things to certain students it goes home and the school board gets calls about it . . . this is not what the community wants so we don't do it.*

One teacher told our URBANVILLE site visitor team:

> *The people who tend to get in trouble using something that's new and different, many times just ask for it by being inflamatory themselves. We always look at these issues in a perspective, with their counterparts, their opposites. We don't say, "Let's have a course on communism, per se." We compare communism with other ideologies.*

and another teacher from URBANVILLE said:

> *Most teachers are very careful about the way in which ideas are presented. That is, they're not afraid of presenting ideas, they just do it in a very professional way. You head off a lot of problems simply by doing that.*

A PINE CITY teacher raised the issue of eugenics and population change through differential birth rates. He was certain that teaching such subject matter would cause problems, and it was clear that he was not suggesting an unbiased presentation either. He wished to attack the subject on a problem-solving basis.

> *I think in the field of education that we're failing miserably when we do not attack our reproductive problem. If you want to, call it "sex education." I don't care what you call it. We presently are probably at a stable population growth throughout the U.S. . . . I believe that we need a thorough course in biology . . . that we need to attack our sex education in a proper, forthright manner . . . (But) if you forthrightly, openly attacked the reproductive problem, issues, etc. and advocated certain types of birth control, then there is that certain amount of puritan spirit that would attack you.*

Advocating a position on a controversial issue was one thing most teachers did not do. Otherwise, almost any topic was fair game for discussion. One teacher said that you could teach anything because, "As long as the kids are quiet and well-satisfied, nobody is really going to care what they're being taught."

We were a little surprised at teacher willingness to discuss subjects which had stirred public reaction in some places. We sometimes thought the school people were overly set on maintaining that there were no constraints on what they may teach. But we were eventually persuaded that most discussed topics they felt a responsibility to teach--and those few topics they felt constrained not to discuss were topics they considered almost always outside their responsibility and desire to teach. So we found essentially no "academic freedom" or "censorship" problems.

We still thought perhaps there may be new taboos which have not been recognized as such. Teachers may have failed to identify them because no one has challenged their absence from the classroom. One possible candidate was cancer, for which there are a number of euphemisms, including "C.A.," and "malignancy," a good indication of heavy social injunctions against its discussion. Death is also a subject that may be considered a potential taboo. In both cases, there have been efforts on

the part of both national leaders and sociologists to bring these topics out into the open, another good indication that a topic is banned. Miscegenation is probably another. It is difficult to imagine a teacher in a southern classroom (or northern, for that matter) feeling free to discuss this subject, even objectively. All this would suggest that if there were taboos, we did not ask the question in the right way to elicit them. If there are new emerging taboos, many adults may be unaware of their existence.

When we asked about controversial subjects in our national survey, almost 1/3 of the parents of seniors felt that federal funds should not be spent on curriculum development in these areas. Almost 60% of the teachers polled supported such development, and 46% of our senior respondents did also.

> Some parents believe that certain topics should be left out of science and social studies courses, topics such as evolution of the species, human reproduction, and family attitudes and customs. Some parents want such things taught, and of course, want them taught well. . . . We need to find out how they feel about using Federal Funds for development of teaching materials that include such controversial topics.

7-9 Soc. Stud. Teachers		10-12 Soc. Stud. Teachers		High School Seniors		Parents of Seniors		
N	%	N	%	N	%	N	%	
5	13%	3	9%	18	21%	35	33%	Federal funds should never be spent on such development
4	7%	7	10%	98	22%	27	12%	It is all right to spend federal funds this way if it will not cause trouble.
25	58%	20	59%	196	46%	63	29%	It is important to provide federal support for such development.
8/41	21%	10/40	22%	42/354	11%	22/147	27%	Other

(Percents reported in this chapter are based on those responding and weighted by states according to the RTI sampling plan. See Chapter 18 for Standard errors.)

It is clear from these results that science and social studies teachers were not without substantial community support for their advocacy of developing better programs in controversial areas. Parents did tend on the whole to be more conservative than teachers about the expenditure of public funds in these areas.

Traditional American Values. When we looked for advocacy of traditional American values in the classroom, we seldom found science teachers explicitly advocating such values--with the exception of conservation of natural resources. While this topic is certain to stir controversy in many communities where industry

and environmentalists clash, teachers in our sites seemed to encounter no noticeable opposition to the very strong positions some of them took. Perhaps conservation education has been a part of school curricula for a long time--since the "dust bowl" of the 1930's, and it is easy now for energy conservation to be added to soil and water conservation. An official of the City of Houston, a strong advocate of energy conservation, mused that school buildings tend to be energy wasteful, while teachers make conservation presentations in class.

Conservation, as a basic American value to be taught to youth, though not alw practiced in the competition for personal wealth, may be closely associated with the "work ethic," productivity of the individual. This is reflected in often quoted sayings. "Waste not, want not," and "A penny saved is a penny earned." Teachers were aware that they were preaching ethical values in this area, but usually felt so strongly about these values that they did not worry much about being indoctrinators. A PINE CITY teacher, who told site visitors enthusiastically about plans to have her students pick up highway litter and measure it, ended by saying:

> *Maybe I'm pushing too much of my own values onto my students because this ecology is a big thing to me, this pollution.*

The Homogeneity of the Community. The level of overt training in values appeared to be strongly related to the homogeneity of the school community and the teacher's integration into the community. Furthermore, specific values, above and beyond those relating to academic preparation and the work ethic, may be developed depending on the cultural background of the school. At BRT, a highly homogeneous site (not one Jewish child in the school, only one black student) and a traditionalist one (people talk about "training future citizens"), one coach-principal talked to site visitors about the role of the social studies teacher in terms of changing the child's value system and affecting the community at large.

> *If a lot of new people came in here, if they were not white Anglo-Saxon protestants or catholics, we'd have trouble, without question. There are a lot of people here whose prejudice isn't that far below the surface. This is a place where a person who teaches the social studies has an obligation to try to open people's minds up a little bit on things such as this. . . . The school is crying for more students but if we have a lot of new people come in, especially different racial and religious groups, they'd have a lot of problems. The whole community would have a lot of problems.*

Observer Jacquetta Hill-Burnett also spelled out the greater freedom that results from having only one ethnic group (black) in the ARCHIPOLIS schools she visited (p 9:24):

> There is a distinct message to all students that getting it together and doing well is not just a matter of individual choice and circumstance, but inevitably has implications for the ethnic group. This sense probably could not have been emphasized to such a degree in a more ethnically heterogeneous student or teacher population. . . .

However, even in a highly homogeneous community such as ALTE, certain values were not discussed. During one site visit, the teacher's question, "What was the dominant attitude of Americans toward the rest of the world at the end of World War II?" drew from one of the students the answer, "That people didn't love each other enough." This was greeted by snickers from his classmates. The teacher elaborated on this briefly, and later confided to the visitor that he certainly wished he could have supported the student more strongly. (The entire incident warrants further reading; see p 16:11.) Both the reactions of the children in the class and the teacher suggested that this one value--agape love--was not comfortably discussed in the classroom.

In more heterogeneous districts, such as URBANVILLE, GREATER BOSTON, FALL RIVER, and WESTERN CITY, there was some reason to believe that the heterogenity itself and the resulting conflict of values limit teachers' freedom to express their values. Someone who has taught in both heterogeneous and homogeneous communities may have noticed what Mrs. N, in BRT described, that student-teacher interactions were far less intimate in a metropolitan school than in the rural school. She liked the fact that she knew much more about her students (e.g., how they felt about things) in BRT than she had known in the large city school, mainly because at BRT they dropped around after school to talk. She knew their parents and older siblings who had gone through that same school before them (observer Allan Peshkin's field notes).

It is fairly clear why a higher level of constraint on the teacher, as far as the expression of individual values, may emerge in schools with a highly diverse population: the teacher's values conflict with those of at least some of the students. Resonating to common personal values makes teaching worthwhile. The teachers remembered best are ones who included students as humans worth caring about, more than ones who were outstanding in physics, mathematics, or social science. A high school senior described such a teacher:

> *He really cared about his students. . . . His way of teaching--he was getting old and wasn't really organized and direct--but I still think he taught a lot, not necessarily about agriculture but about human morals, human life, how to be a good human.*

But it is more difficult to care about those whose cultural values are strange.

One ALTE teacher told site visitors that if the high school social studies department to which she belonged were to become involved in an inter-departmental effort to improve student reading and writing, about which teachers and parents were complaining, "the teachers would lose their academic freedom." It appeared more sensible to her to have someone else do it and keep ill-prepared students out of "good" classes. Teacher pride and prestige in their discipline were often communicated to students as values. One result of heterogeneity was that teachers felt less influential in the guidance of children. As pressures constraining the teaching of values directly were reduced, the teacher's perception of his/her function seemed to diminish toward one of relaying facts. At any rate, we often found that physics and chemistry were perceived as cut-and-dried collections of facts that could be adequately treated by simply relating them, without emotional connotations, without enthusiasm, without excitement, without creative insight.

Biology usually involved more emotional experiences. For example, there were animals in the animal cage: some were loved, some were feared, some were killed, some were born. Students expressed their own values about these experiences.

If the school's role in the transmission of ethical values is diminishing we suspect that the more nurturing teachers will find teaching more and more onerous. A teacher who conceives school as a communication system relaying facts may survive in a heterogeneous, highly political school system better than one who sees it as a social system developing values. For good or ill, most teachers in our sites continued to find a way to become involved emotionally and to teach values--although they often were not ones idealized by science education specialists. (See pp 16:7 through 16:11 and chap. 16 passim.)

Ritual and Mathematics. In the public schools, overt religious and ethical instruction has been diminished through national decisions and changed perceptions about what is properly discussed there. The enforcement of integration law and a growing recognition of our pluralism, and the accompanying decline of the melting pot ideology, has left many teachers confused as to what formal and informal codes the schools should enforce. Still, we found a high level of covert moral instruction. It was accomplished partly through ritual, some of which is unique to the school (e.g., testing, reporting attendance, asking permission to leave the room) and some of which is common to the culture (e.g., saying please and thank you, waiting your turn in cafeteria lines).

We considered an act ritualistic if certain aspects of its performance had no direct relationship to the recognized or stated goal of the activity. In many cases involving school conduct, the line between what is patently functional and what is perceived as merely ritualistic was not easy to draw. It in fact shifted depending on the circumstances and the participants involved. For example, maintaining a certain level of order in the classroom was apparently necessary for teaching and learning to occur, but maintaining the level of order that had traditionally been maintained (having a student ask for permission to sharpen a pencil) was probably ritualistic. Requiring that a child ask permission to go to the bathroom or to approach the teacher was probably functional for the teacher but ritualistic for the child.

We were told that patriotic and religious rituals were being reduced--although prayers were still maintained in two southern-site schools. Dress codes were not obvious. Standing when visitors or the principal entered the classroom appeared to be a disappearing custom. One teacher in GREATER BOSTON confided to a site visitor that the teachers were too lax about student comportment--but because the teacher wishes were in opposition to student wishes, teachers could no longer exert strict control and survive. Obeying rules of courtesy (standing when an older person enters) is not only a sign of respect; it is tone to teach respect. The youngster's perception of the older changes as he stands, perhaps as the Thai's perception of his king changed as he kissed the ground at his feet. A teacher's recognition of ritual was put this way at our rural trial site:

> *I still think America came farther and faster than any nation in history under the old method of teaching, where we had some discipline in the classroom, we did some drill because it was what*

teachers deemed was necessary, we didn't have to try to justify all that we did.

Anthropologists have maintained that a certain level of ritual is necessary for social systems and cultures. If many traditional rituals are disappearing (perhaps in response to the same pluralism that seems to be attenuating the explicit teaching of values), other rituals may be adopted by teachers to provide the same underlying function of moral training and control. However, the level of school ritual that students will tolerate will, to some extent, be influenced by their perception of what constitutes an educated person. When classic education was standard, it was necessary to participate in the ritual learning of "dead" languages--whose value for speaking, reading, or writing was almost nil. If an education is seen as most successful when it results in highly lucrative employment, then the rituals that will be sustained will be ones that are performed by the rich. Cynicism will probably continue to devalue most recognized rituals but the number of rituals will not necessarily decline. Tangible rewards such as the ability to manipulate environments or people may now be replacing the intangible rewards for completing the ritual.

Good candidates for a ritual to fill "the vacuum" are subjects whose functions have recently been severely curtailed in terms of real utility and whose teaching has been highly structured. Arithmetic is apparently such a subject. First, with the almost universal distribution of pocket calculators, there is much less purpose in computational drill. We also heard from a number of people, including an engineer-parent quoted here, that even advanced high school mathematics had little practical value. He said:

> *I never used algebra or trigonometry or solid geometry when I got out of school but that's what they taught in junior and senior math, and I've often wondered, "why?" Where would the average person ever run into the need for that type of math?*

However, both teachers and parents see the performance of certain arithmetic skill as having a socializing value. One teacher claimed that the student who did not succeed in this area would not succeed as a citizen:

> *This particular student in individualized instruction is working toward the right answer only and really has no understanding of the problem, whether it's mathematics or science, and this student will probably be the individual that someday will be out in society not really understanding what he's doing in his home or any other facet of the environment.*

When the subject of hand calculators was raised with the group of URBANVILLE parents, the level of emotional response suggested that the topic was not one of utility but of ritual, which typically has a higher affective component. They said:

> *I think using hand calculators is an awful shame because that's why our brains are going so lazy.*
>
> *Calculators should be forbidden in math classes, at any level, because even in higher algebra and trig processes, the learning process is by doing it.*

> *Kids are lazy, people are lazy, I'm lazy - and you're going to get by with as little as you can. . . . I think they should be required to take a little more. The program is getting watered down.*

It perhaps is significant that elementary school teachers resisted any diminution of instruction in arithmetic, even though many of them showed a high level of anxiety about it. Is a component of this anxiety the fear of failing in the performance of a ritual?

School people and the public were making a strong defense for preserving traditional subjects having ritualistic force. Some seemed to be used in imbuing moral attitudes related to work ethic: responsibility, diligence, persistence, thoroughness, neatness. Instilling such disciplinary traits was sometimes a more primary function of the school it seemed than disseminating information. As we were reminded by Preston Ward, the manager of a manufacturing company in PINE CITY (see p6:48 for full quote):

> *I don't want to be seen as criticizing the co-op program because I think they do a really good job. But what is most important about the program is the attitude that the students learn towards work rather than the job training they get.*

It seemed that the teacher may overtly teach those moral values and demand compliance with rituals which relate to the work ethic without loss of community support. Their association with science is not recognized in the language and theory of education or in the official goals of the school. In other cases, such as the taboo areas reviewed above, the school was no longer seen as the appropriate arena for moral instruction and guidance, only for the dispensing of information.

What are the implications of these perceptions of mathematics (and some aspects of natural and social science) particularly for NSF? It seems that inventing more successful materials and methods in mathematics/arithmetic will be a more difficult and complex task than has been imagined heretofore, because it is one of those remaining areas which have a ritualistic function in school.

The Teaching of Values and the Social Sciences. Social scientists explicitly study human value systems, and social studies teachers have traditionally aimed to inculcate the American way of life. Yet as we talked to social studies teachers it seemed to us that they were more diverse (than science or math teachers) in their expressions of values in their classes. The diversity of perspectives in the social sciences may cause the diverse approaches to social and personal values we found in the social studies teachers.

In our national survey we included several items regarding the teaching of values and the control of bias. In one situation we asked 150 social studies teachers, about 300 senior students and their parents (one parent for each) about the emphasis on personal values in high school social studies courses. We found that most respondents did not indicate a need for change in emphasis but of those who did the preponderance of respondents asked for more emphasis rather than less. More than one of three parents and students indicated a preference for greater emphasis on teaching about personal values.

The question went like this:

> As you look at social studies courses in your high school and elsewhere, you probably see things that concern you. Please check those things below that you consider major problems. (Check as many as you wish.)

7-9 Soc. studies teachers N	%	10-12 Soc. studies teachers N	%	seniors N	%	parents of seniors N	%	
18	36%	13	27%	168	40%	32	14%	Too much emphasis on facts, not enough on concepts.
8	16%	11	26%	47	13%	33	39%	Too much emphasis on concepts, not enough on facts.
4	8%	2	4%	43	8%	14	5%	Too much emphasis on teaching about personal values.
12	24%	13	27%	122	35%	49	36%	Not enough emphasis on teaching about personal values.
7	16%	5	21%	75	23%	48	47%	Not enough qualified teachers.
9	17%	10	16%	104	17%	22	16%	Belief that teachers teaching the same course should teach the same things
42		41		307		146		

The other responses will be discussed in Chapters 13 and 14

In the survey questionnaire, we presented the scenario below to stimulate thinking about the matter of freedom of teachers, and students, to express the biases they have. It was presented to social studies teachers in both junior and senior high schools, high school seniors, and parents of seniors.

Scenario Y

==========

At Metro High School, Mr. Robinson's American History class is studying immigration and the settlement of America, noting particularly how immigrants have influenced the growth of their city. Here is a dialogue midway through Monday's class:

Mr. Robinson: After the Irish immigration of the 1840's and after the importation of Chinese laborers, what other waves of immigration occurred? Sally?

Sally: Europeans around 1890 and then again after World War I.

Mr. Robinson: Good. I guess that's when we got our Polish jokes, right? (no one laughs) Well, let's see. What sort of long-time trend are we studying?

Sally: People coming to America.

Mr. Robinson: Why did they come, Tammie?

Tammie: To come to a country with freedom.

Doug: (sarcastically) Like freedom to pick cotton.

Mr. Robinson: Well, let's think about that. Some of the early colonists were seeking freedom. Were the Chinese who came after the Civil War seeking freedom? (no answer) What were they looking for? (no answer) What were the Irish looking for?

Wendy: Food!

Mr. Robinson: Food more than freedom? Let's make a list of possible reasons, then consider each one.

Eric: My dad says we should be studying how to send them back where they came from rather than how they got here.

Mr. Robinson: Okay, that's an idea. After we make our list of reasons for immigration, let's figure out who wanted the immigrants here and who didn't want them. And then let's decide whether I should be sent back to Africa or Europe.

Scenario Y

Mr. Robinson is asking questions about history and joking about it. What is your reaction to his teaching style?

7-9 Soc. Studies Teachers N	%	10-12 Soc. Studies Teachers N	%	Seniors N	%	Parents of Seniors N	%	
27	51%	22	54%	186	61%	87	41%	It is fine for some teachers to teach this way. It gets their attention.
3	22%	3	16%	26	9%	20	19%	I find it offensive.
5	16%	7	12%	70	18%	27	28%	I don't mind, but he is not likely to to get the job done.
7	12%	1	2%	71	11%	11	12%	Fine in principle, but . . .
42		41		370		146		(Total Responding)

Do teachers and students talk like this in your school(s)?

7-9 Soc. Studies Teachers N	%	10-12 Soc. Studies Teachers N	%	Seniors N	%	Parents of Seniors N	%	
8	11%	9	31%	55	14%	34	21%	Yes, lots do.
26	55%	24	46%	261	56%	83	32%	Yes, a few do.
6	28%	7	22%	44	30%	14	43%	No.
2	6%	1	1%	1	-	10	3%	Other.

Scenario Y

How common is it for teachers in your school(s) to try to teach the scientific analysis of social problems?

7-9 Soc. Studies Teachers N	%	10-12 Soc. Studies Teachers N	%	Seniors N	%	Parents of Seniors N	%	
3	5%	7	20%	48	8%	11	2%	Quite common
7	17%	7	18%	81	23%	21	25%	Sometimes
9	20%	3	10%	25	15%	5	2%	Never
5	13%	-	-	6	1%	26	10%	Don't know
-	-	-	-	-	-	-	-	Not school's job
1	3%	2	3%	53	10%	5	2%	Some teachers do
-	-	-	-	-	-	-	-	What is it?
-	-	-	-	1	5%	-	-	Communist
13	20%	14	27%	62	15%	21	16%	Other
4	23%	8	22%	85	24%	59	43%	No Comment

Perhaps the most impressive finding from the questions relating to this scenario was high proportion (more than 70% in three groups, and nearly 60% in the fourth) of seniors, parents of seniors, and junior high and senior high school teachers who felt that teachers should express their own feelings, but present alternative views too. The fact that 24% of the parents of seniors felt that teachers should keep their biases to themselves could be a critical factor, however, since only one or two concerned parents can upset school operations by pleading to the school board, or ultimately to the Supreme Court. The question presented and the responses were as follows:

> Mr. Robinson seems reluctant to accept the idea that most immigrants come to America seeking freedom. Let us suppose this is a bias of his. How important is it for social studies teachers to keep their biases to themselves?

7-9 Soc. Studies Teachers N	%	10-12 Soc. Studies Teachers N	%	Seniors N	%	Parents of Seniors N	%	
9	15%	5	16%	44	11%	40	24%	They should recognize their biases and keep them to themselves.
1	2%	1	2%	31	7%	6	1%	They should speak honestly as to how they feel on matters.
26	72%	25	59%	254	78%	94	72%	They should tell how they feel but present alternative views too.
6	11%	10	23%	30	4%	6	3%	Other
42		41		359		146		(Total Responding)

In response to an even more specific question on this topic, a surprisingly high percentage of our respondents seemed to be supporting the teacher's expression of his/her social judgments in the classroom, provided he/she indicated his value-orientation. As in the preceding question, approximately one-quarter of the parents of seniors polled indicated it was wrong for the teacher to do this, a fact which probably explains the low frequency of this sort of teaching. The question was:

> Suppose Mr. Robinson was leading up to a critical analysis of the free enterprise system. Suppose he intended to say that the system was dishonest, that it was cruel in the way it imported cheap labor from foreign lands to work in this country. Do you feel that it would be inappropriate for Mr. Robinson to acquaint the students with his conclusions about the free enterprise system in early America?

7-9 Soc. Studies Teachers N	%	10-12 Soc. Studies Teachers N	%	Seniors N	%	Parents of Seniors N	%	
6	9%	1	1%	55	15%	32	11%	It would be right, in fact it is his responsibility to be frank.
24	61%	30	75%	165	41%	72	46%	It would be all right as long as he indicated his value-orientation.
3	6%	0	0	16	8%	6	14%	It is ethically proper, but it would be foolish to do so.
6	16%	3	5%	65	19%	28	23%	It is wrong for him to use his position for teaching those things.
3	8%	7	20%	53	17%	9	5%	Other (please explain)
42		41		354		147		(Total Responding)

The scientific code of indicating one's bias has the strongest support, but 9% of the junior high school teachers chose frankness without such an indication of bias.

SCIENCE FOR THE CITIZEN

Some science for every citizen is found in our case study sites. In science education, efforts to make science relevant to the concerns of all--not just the college bound nor the exceptionally talented student nor those anxiously looking for a job--were found. To make the study of science attractive, popular, and useful is important. To involve all students in some exposure to science is one of the aims of science education as we have found it in our studies.

Science as General Education. Each of the sites had a commitment to science in general education. Each had a general education course of study that included some work in the sciences. General education courses of study, in most instances, referred to the courses of study taken by students not in either a college preparatory or vocational track. Often students in those tracks were also expected to complete "general education requirements."

The idea of general education probably developed out of the liberal arts tradition. Many would agree with the following statement by Broudy* as a good definition of the purposes of general education:

> *The special domain of the school has been knowledge, truth as certified by those expert in its discovery, defense, preservation, and promulgation. The autonomy of schools needs no other or more ultimate legitimation. This is the knowledge that can make men free. . . . In general education, the school would induct every pupil into the vestibules of connoisseurship in all phases of human life. It would preach openly that not only is the unexamined life not worth living, but that the cultivation of one's power for living well is a duty as well as a high privilege.*

This seems to be a desirable goal statement for general education. However, the implementation process has resulted in an operational definition that is much more utilitarian in nature. General education courses of study were oriented more towards the idea of "minimal competences" or "functional literacy" than toward induction into "vestibules of connoisseurship." General education is as preparatory as is college prep and vocational education. The field observer at RIVER ACRES did not differentiate among courses of study when he observed that (p 1:12):

> teachers see their. . . teaching as getting youngsters ready. Preparation for the next grade; . . . for the more difficult courses to come; . . . for life.

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*Harry S. Broudy, The Real World of the Public Schools (New York: Harcourt, Brace, Jovanovich, Inc., 1972), p. 230.

Students were considered to be prepared (at least minimally) when they have acquired knowledge, competence, and skill in certain areas of content. They have been prepared for the world in the sense of being able to make the appropriate response. They were perhaps less so prepared in the sense of understanding the world and themselves.

A general education course of study was usually much more flexible in terms of requirements than college prep or vocational education. The requirements in general education essentially defined the minimum referred to in the previous paragraph. The electives, of which there were usually many, constituted a sort of potpourri of things that are nice to know. The selection of electives may come in handy someday or may be of sufficient interest to keep one in school. The pattern of electives did not seem to have a coherence that would contribute to the students' attaining the kind of general education that Broudy espouses.

This circumstance was probably due to several factors. One factor which certainly had much impact on general education was the majority of students in the general education course of study who were characterized as "less able and/or willing." Teachers would surely like to help them see the broad picture. But the frustrations in trying to do so are exemplified by a comment of a teacher in PINE CITY (p-6:18).

> *In general science classes we have general to basic students. I think the only way to reach them is to teach them something they can relate to, i.e., no abstractions. I have left the book almost entirely in order to teach things they can relate to and enjoy and I find I get more response and motivation in this way. (emphasis added)*

General education requirements in the sciences were remarkably similar across the sites. In mathematics, the requirement was usually two years of mathematics beyond the elementary grades. This requirement could be met with courses that were essentially repetition of elementary school arithmetic although most general education students take one year of algebra. There seemed to be little attempt made to stimulate the interest of general education students in mathematics beyond the minimal requirement.

The social studies requirement typically involved four years beyond elementary grades. Course titles were: World History, American History, Government/Civics, and perhaps some geography. Study of state history was required at most sites. Most of the sites offered a variety of electives in social studies in an attempt to stimulate additional study in this area. Psychology, sociology, and economics were course titles found at most sites. Anthropology, History of Latin America, and Philosophy were examples of less commonly found courses that probably reflected an interest or concern of a teacher or particular community.

The general education requirements in science were typically two or three years of study beyond elementary school. The course titles were general science, physical science, earth science, and life science or biology. Tenth grade biology seemed to be as much a part of the American scene as apple pie. The science experience of general education students usually culminated with biology. Physics and chemistry were taken almost exclusively by college prep students only.

General education a la Broudy has long been a goal of American schools and most schools have some sort of general education course of study. It has been apparent, however, that the course of study as we saw it has not achieved the goal. Different attempts have been made to arrange curricula courses to enhance general education (e.g., core curriculum, interdisciplinary studies). There were signs that environmental education was providing for the effective integration of subject matter that stimulates the students to "examine the life worth living." A FALL RIVER teacher defended his course as follows (p 2:6):

> *The person just can't be an effective citizen unless he can read and understand political issues that have scientific overtones . . . The average citizen has to have the awareness and appreciation of how his actions affect the environment and what is likely to happen depending on the choices he makes now.*

While the quote suggests a "preparation" purpose, it also reflects a recognition that examination of one's life and the world requires integration.

Popular Science. Many of the sites tried to stimulate general education students as well as students in other tracks to study science beyond the requirements. They do so with an attractive elective program. (See ALTE, FALL RIVER, RIVER ACRES, URBANVILLE, WESTERN CITY.) The electives have titles that reflect an attempt to "popularize science" or to provide students with a base for dealing with issues that are science related and of interest to all citizens, e.g., environment and ecology. Examples of elective course titles were oceanography, marine biology, plants, mechanics, genetics, electronics, space science, environmental studies, and ecological studies.

Around the country, we found a spate of new course offerings and programs that appeared to be attempts to make science relevant to the "here and now" pop scene. These include URBANVILLE's horticulture program (p 5:5) and wildflower/edibles course (p 5:4). FALL RIVER's TREK program was structured around knowledge of the galaxy and includes such high interest topics as black holes and UFO's (p 2:15), and the community study projects conducted in VORTEX (p 10:10) and ALTE (p 3:49). There were also outdoor education experiences which were very popular with both students and teachers. (See Chapter 13, Out of School Learning.) These included FALL RIVER's Eco-Week (p 2:22) and ARCHIPOLIS' Field Science Camp at Mt. Airy (p 9:17).

From WESTERN CITY site visitor Charles Weller reported:

> The school I visited was 30-50 years old and was anything but elaborate. It had a contained courtyard approximately 100 feet by 150 feet. There were no [scheduled times for] the science curriculum, there were teachers identified as science teachers. The principal was an ex-science teacher and a believer in a do-it-yourself philosophy of teaching--students, teachers, et al.

The courtyard provided the primary focus for a variety of dynamic science activities and projects, though the extent of them was by no means limited to the courtyard nor to science. Some of the different projects in the courtyard were:

Running Water Pond with Waterfall
Greenhouse for Plants and Seedlings
Individual Vegetable Garden Plots
Concrete Walled Snake Pit
Two Aviaries with Tortoises
Lapidary with Cutting, Grinding, Polishing Wheels
Mosaic
Mountain (under construction)

The noteworthy aspect of this whole undertaking is that all of the work was done by students under the supervision of teachers. Most of the materials were scrounged. Only the wood, screen and cement needed to construct the various projects were purchased by the school. Vandalism was practically nonexistent despite the fact that students had free access to the courtyard during lunch and other times. The reason given was that they felt it was theirs. (The one exception was that radishes seemed to disappear as soon as they got to be eating size.)

From a number of quarters we have heard about the impact of television on the interests of students. Interest in such programs as "Wild Kingdom" and the Jacques Cousteau series were mentioned (PINE CITY, p 30). In an effort to respond to popular interests, teachers occasionally integrated what they were teaching in the classroom with TV programs. (In one of our site visits, a teacher described his social studies unit on Africa which concluded with the series, "Roots.")

Some attempts to popularize science with elective courses seemed to be experiencing difficulty as they ran counter to the "budget crunch" forces. A VORTEX science department head complained that "they've cut the heart out of our elective program" with the budget cuts.

In spite of "budget crunch" backlash, new methods of course delivery were being tried out to in some way draw students to science. In our urban trial site, a science coordinator told us:

There's a growing emphasis on the mini-course. Some courses are offered in different packages--for example, a twelve-week package, an eight-week package. Maybe they're the old units we used to teach out of a biology course, but we're going to have a mini-course in plant growing, or photosynthesis. There will be a different breakdown in the curriculum. Maybe we're doing it because we have to compete with the other subject areas. So many other kinds of exciting things being offered to them. We can offer as much if we perhaps modify our approach.

Practical Science ("Survival Science"). In all science courses, in particular the general science courses, there was often an emphasis on "things that will be useful in every day living."

Steve, a high school junior from BRT, said (p 4:20):

> *I think science helps you find out about yourself, what you can and can't do with your body . . . I eat more bread and milk than I used to since takin~ Biology when we studied calories. If you're healthy, you live longer, and I want to stay around as long as I can.*

Many parents showed a similar concern with the practical side of science. A parent during one of our site visits spoke about science education directed to personal safety:

> *Is it feasible for the National Science Foundation through its education programs to help establish programs, including effective retraining programs, so that people can be better trained in [the] hazards of the new agricultural technologies?*

Many high school level basic math teachers were concerned with providing their students with the skills and abilities necessary for the routine day-to-day responsibilities of the average adult. The URBANVILLE math chairman talked about the thrust of his program:

> *We made a list of sixteen survival skills, and with those survival skills we tried to pick out the mathematical concepts that were necessary and we designed a test, for one thing, to measure the students on those particular areas. And then we were to . . . come up with some techniques with "hands on" type materials . . . that would give the students an opportunity to visualize a certain concept rather than to have it abstract.*

In addition to personal survival, we found a concern for survival of society as a group in our site visits. The following quote is from the BRT case study (p 4:42):

> *Our students have to think in terms of a world a little larger than this community, so far as problems are concerned. We had this film the other day in sociology, Black and White Uptight. A good film on the race issue. The class didn't want to discuss it.*

A site visitor in PINE CITY expressed a desire in making the general population ecologically aware as a means of preserving the physical environment:

> I'm concerned that we should teach all of our citizens. . . the things in life that are of value, the natural things we should not destroy, that we should appreciate and that ~ can use, both professionally and recreationally. Making people aware of the shortage of natural resources is a very difficult thing.

"Science for the citizen" thus appears to mean somewhat different things to different perspectives. All of the sites show signs of what NSF has termed "scientific literacy" and we have renamed "science for the citizen." Interest in providing science that relates to everyday circumstances was found in all sites. Courses and curriculum were centered in many cases around practical concerns to which some scientific knowledge is germane. "General science" was found not only in general science courses but also in the specialized sciences such as physics and biology.

Science education is involved in making useful what has often times been characterized as abstract and esoteric. This was well stated by a physics teacher from FALL RIVER (p 2:7):

> *In recent years I've wondered if you could justify it [physics]. Earlier I would have said that physics was a part of cultural knowledge, something enormously practical, like all sciences having something philosophically to offer the public, an intellectual integrity which could carry over into politics and society.*
>
> *Now I don't know. We live in a technological society so it is necessary to propagate information to some parts of the society. But for the general person in high school who will eventually go into business or become a homemaker, they really don't need to know about physics, except in a very superficial way. If you want a kid to know how to change a tire, you teach him about levers . . . I'm a good sailor and I apply my knowledge of physics, but other people are better sailors and have no physics background.*
>
> *That is too pessimistic. Let me state it this way. Everyone deals with nature. Every high school student knows a great deal of physics and the teacher merely encourages him to abstract his knowledge to form more general and sometimes more useful patterns of thought. If the student can deal with ideas in the abstract, he learns this <u>before</u> going to college and can thereby make a sounder choice of careers. He may not do better than another competent college student, but he has had the benefit of guidance and proven academic discipline. Finally, and this is important for all ability ranges of students, a sense of being at home in the universe . . . The physical world and the technology of man must be dealt with as an important part of the total culture he is to inherit.*
>
> *My greatest contribution is to get students to grow intellectually as much as possible. If a kid doesn't appreciate a subtlety of physics it doesn't bother me. I'd like to bring each kid as far as he can go. What I'm definitely <u>not</u> doing, but used to do, is to prepare Ph.D. physicists. I was looking for that occasional student--but he only comes around about every four years, and running the class at that level . . . that's no longer how I want to work.*
>
> *I don't think that this [less rigor] hurts the college-bound. From the statistics I've seen it makes no difference in college freshman physics whether the person has had physics in high school or not. How he does in college is more dependent on his intelligence and motivation rather than his high school preparation. . . .*

Chapter 13

THE K-12 CURRICULUM

One parent told us, "I do wish all the school systems were taught at the same level." To the child transferring to a new school, the new courses may look frighteningly different, with regard to subject-matter content as well as with regard to the level at which they are taught. To some visitors to schools around the country during the 1976-77 school year, the courses looked very much the same. Individual teachers did things differently; standards of acceptable performance did vary; the circumstances of learning were of 57 varieties--but the textbooks were the same (see the final section of this chapter); the tests were the same; and the country had--not a nationally imposed curriculum--but local acceptance of a nationwide curriculum. The "effective" curriculum that each child confronted may have differed immensely at two adjacent desks but the formal curriculum the school district offers was almost constant across the country.

The principal purpose of beginning the reform of curricula in the mid-1950's was to give local districts or individual teachers an opportunity to choose other (particularly more disciplinary-conceptualized) curricular offerings. The movement apparently succeeded in that aim*--even though it turned out that for various reasons, except in biology, districts and teachers usually did not choose the new materials. We believe we have, in Chapter 16, some particularly useful insights into the reasons for their preferences and will outline them briefly here so that the reader can keep that in mind while considering in this chapter the subject matter that was being taught in the mid-1970's.

The uses teachers made of subject matter in their craft, while usually "justified" in terms of learning goals, were often far removed from the learning goals of the curriculum developer, the education theoretician, or the methods specialist. Parents and administrators had particular interests in how the teacher used subject matter. If Johnny or Suzie felt treated unfairly in being asked certain questions in class, he or she was upset. If parents felt that essential content for college preparation was being underemphasized, they complained. If administrators found that the teacher was not oriented toward respectable course objectives, they wanted to get things straightened out. Those folks had their goals, and the work of the teacher had a lot to do with whether or not they reached their goals.

But the teacher also had goals--survival, staying out of trouble, feeling good, not getting transferred, helping kids get ready for something, etc. The teacher sometimes punished misbehavior by having Johnny or Suzie stay in during recess and work ten extra arithmetic problems. It was not because course-content is epistemologically linked to maintaining control of the classroom--but the teacher had to do both, so why not do them together? To "just keep going," teachers found they had to use subject matter in ways that were not discussed outside school (techniques for which new teachers are ill-prepared). These maintenance techniques, mastered and depended on, then were threatened by the new

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*Robert E. Stake, "The Legacy of the Curriculum Development Movement" (Paper delivered at the AERA Annual Meeting, New York, NY, April 7, 1977).

innovative learning materials and methods. The innovators did not use subject matter in the way this teacher did.

Education does not have an adequate theory of instruction* now for analyzing and planning and dealing with the diversity of uses of subject matter we found in the classroom. The rational perspective was nicely dealt with by Smith and Meux "logic of teaching" and the personal culture of teaching also in such writings as Smith and Goeffrey's "ethnography of the urban classroom,"** but none of these dealt sufficiently in 1977 with the influence of social, political and economic influences on courses taught in school. In particular they did not sufficiently connect the task-analytic frame of mind (required by the current management of schools) with what subject matter scholars thought the content of the curriculum should be.

The critics of course content improvement efforts of the 1960's tended to overlook the nature of these problems in the late 1970's. According to James Fey (interviewed by Gina Bari Kolata), John Goodlad, and Donald Schön,*** for example, the developers failed to comprehend the necessity for gradually preparing teachers to try out the new ideas. That is true, but a truism. Those curriculum developers who did go to great effort to secure sincere commitment of faculties, administrators and parents to a new program usually found that their innovations had a longer life in schools, but even there the spread was slow and the counter-pressures ultimately prevailed.

In the eleven districts in which we placed CSSE field observers, classes in science, mathematics, and social studies using innovative materials were relatively rare. Inquiry teaching--featuring teachers thoroughly trained in institutes and elsewhere to ask leading questions and promote personal exploration--was noted in just three classrooms. Only a few teachers remained enthused about those innovations, most disparaged them and appealed for "a return to the basics."

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*See Richard Snow, "Individual Differences and Instructional Theory," Educational Researcher, 6 (November 1977): 11-15.

**B. O. Smith and M. Meux, A Study of the Logic of Teaching (Urbana, Illinois: Bureau of Educational Research, University of Illinois, n.d.); and Louis M. Smith and W. Geoffrey, The Complexities of an Urban Classroom: An Analysis Toward a General Theory of Teaching (New York: Holt, Rinehart and Winston, 1968).

***Gina Bari Kolata, "Aftermath of the New Math: Its Originators Defend It," Science, 4 March 1977, pp 854-857; John I. Goodlad, Frances M. Klein and Associates, Looking Behind the Classroom Door, 2d ed. (Worthington, Ohio: Charles A. Jones, 1974); and Donald A. Schön, "Whatever Happened to Curriculum Reform?" The National Elementary Principal 56 (September/October 1976).

The emphasis on a "basic skills" curriculum was an almost universal finding in these case studies. It will be discussed at length in this chapter. A look at the case studies in terms of the relationships between curriculum development and student performance testing will be found in Chapter 15. What comes next is a separate review of three subject matter areas: science, mathematics and social studies. In this chapter we will also discuss "curriculum out-of-school" and materials of instruction.

Science

BIOLOGY-CHEMISTRY-PHYSICS

As one reads through the case studies one is struck by the diversity of the many opportunities to learn science. This diversity existed within school buildings and departments, mostly as a difference among teachers, as pointed out by Mary Lee Smith in her concluding remarks in the FALL RIVER study (p 2:41). Some differences were found at the district level. FALL RIVER offered as many as eighteen different science courses in a semester. PINE CITY and BRT, on the other hand, offered as few as five courses, always depending on meeting minimum enrollments. ALTE had elaborate sequences of science courses designed to meet the needs of students with different career aspirations.

Less obvious according to statistical studies but greatly obvious to observers were the extent to which course content, format and teaching method differed among individual science classes. Even though teachers might use the same texts, they improvised to such an extent that two otherwise seemingly identical courses look greatly unalike. Examples of this are sprinkled throughout the case studies. One could not avoid the inference that teachers develop and follow their own guidelines.

The teaching styles and strategies employed by teachers are at least as varied as the contents and formats of their courses. Some employed Socratic inquiry and denounced laboratory investigations (RIVER ACRES, p 1:92); others praised laboratory investigations and admitted they had difficulty asking the right questions (BRT, p 4:10). In any event, teacher autonomy with regard to what is taught and how it is taught appeared widespread and should not be discounted by anyone concerned with the status and/or improvement of science education in the United States.

Despite the diversity in programs, content and methods, there are factors or trends that seemed to be universal. In every site courses identified (or identifiable) as biology, chemistry, and physics were offered. These courses usually appeared in the same sequence: biology--chemistry--physics. (In the one instance where the sequence ran biology--physics--chemistry, VORTEX, p 10:9, it was interesting to note that the chemistry teachers were the longest-tenured and most established people in the science department.) More often, chemistry and physics were usually offered as electives. Biology was often a required course, sometimes preceded by general science, physical science, or earth science. As we were reminded in a NEWS NOTES TO PARENTS from a district near Milwaukee: "All students must take biology because it is a lab science, and we are committed to exposing each student to the processes of the laboratory."

As one might expect, given the above sequence and requirement-elective format, most students would take biology, relatively few take chemistry and very few take physics. Consistent with this breakdown, we also found only the most able students enrolled in chemistry and physics. Physics was described as one place on the "top of the pyramid" (RIVER ACRES, p 1:90). It appeared not uncommon for chemistry and especially physics teachers to feel that their courses are for the academically elite and to feel there is no need to try to increase enrollments (URBANVILLE, p 5:5).

A trend that seemed to be occurring, possibly related to the elitism discussed in Chapter 12, was a decline in enrollments in chemistry and physics. Several schools had been experiencing such a decline for several years even though in 1976-77 the total high school enrollment decline had just begun its decade of decline.* Enrollments in these academic electives was dropping faster than enrollment in science courses in general (VORTEX, p 10:10). What explanations did we hear?--more competition from other elective courses; the image of science and scientists is bad (reported in one school, FALL RIVER, p 2:7ff); reduced graduation requirements; opportunity to pick these subjects up in junior college, if needed; and the perception of high school students that the content of physics and chemistry are just not relevant. Undoubtedly the individual teacher plays an important role in attracting students to his/her courses. In an instance (WESTERN CITY, p 7:23) where physics enrollment showed a slight increase after several years of decline, the physics teacher was settling into her third year and was highly respected by students.

In our CSSE survey, we asked three groups about things that are wrong with high school science courses at the present time. We asked high school science teachers, high school counselors and high school seniors. They could check as many things as they wished from the things we listed and add others. The results were as follows:

RESPONDED:	101 of 150 Teachers	46 of 86 Counselors	375 of 375 Seniors
__Too much time must be spent on remedial mathematics	63%	29%	19%
__Too much time must be spent on teaching reading	48%	15%	11%
__Too little attention is given individual students	34%	20%	36%
__Too little help is available to the teacher with teaching problems	41%	20%	21%
__Class periods are too short, classes too large	62%	16%	22%
__Lab facilities or field arrangements are inadequate	51%	73%	34%
__The public and administrators are pushing for the wrong things	45%	6%	20%
__Other	19%	25%	23%

(Percents based on those responding; percents are weighted; standard errors are available in Chapter 18.)

*We asked science curriculum supervisors to what extend enrollments in science changed in the last five years. Of 200 sampled, 132 responded but 14 of these disregarded the question. From the remaining we categorized their statements (and weighted them by the RTI sampling plan) to get the following projections:

in 18% of the districts an increase in science enrollments
in 48% of the districts a decrease in science enrollments
in 21% of the districts stable science enrollments
while in 12% of the districts the picture was something else.

The teachers in our sample were inclined to mark three or four weaknesses whereas the counselors and students one or two. The teachers pointed to things that impeded their teaching, particularly remedial instruction in mathematics and the shortage of time and size of the class. The counselors were particularly impressed with inadequate lab facilities and field arrangements, and students and teachers took note of that too. The shortcoming most noted by senior students was the little attention given to individual students. These responses confirmed observations made in the case study reports.

We asked the senior students in twenty-eight districts around the country what they considered the one thing most wrong with the science courses they had taken. The number responding was 336. Using percents weighted according to the RTI sampling plan we found that

29% checked that "the courses were boring"
24% checked that (the courses) "overemphasized facts and memorization"
19% checked that there was "not enough lab and project work"
15% checked that the "books and equipment were inadequate"
7% checked that "the courses were impractical"
7% checked that the courses were "too much aimed at the 'bright' kids"

We also asked them what they considered the one thing most right about those science courses. The number responding was 342. We found that

22% checked that "(the courses) stressed the basic facts"
20% checked that "the courses were interesting"
19% checked that the "books and equipment were very good"
19% checked that the "classes have been small"
14% checked that "they stressed fundamental ideas
6% checked that "the courses were 'down to earth'"

These data gave us the impression that the students were sensitive to and divided on the issue of stressing the "basic facts" in high school science. Some liked it, some did not. Charges that the courses were undesireably elitist or impractical did not get much support from these students.

ELEMENTARY SCIENCE PROGRAMS

Most schools we studied had some written policy about what and how elementary science should be taught (URBANVILLE, RIVER ACRES, FALL RIVER, ALTE), but what actually was taughtwas left largely to individual teachers (BRT, FALL RIVER, RIVER ACRES). By and large, the elementary teachers did not feel confident about their knowledge of science, especially about their understanding of science concepts. Even those few who did like science and felt confident in their understanding of at least certain aspects of it often felt that they did not have the time nor material resources to develop what they thought would be a meaningful program (ARCHIPOLIS, p 9:3; WESTERN CITY site visit report Weller. As a consequence, science had been deemphasized at the elementary school level, with some teachers ignoring it completely.

When and where science was formally taught, the instructional material was usually taken directly from a textbook series (URBANVILLE, ARCHIPOLIS, RIVER ACRES, FALL RIVER). The method of presentation was: assign - recite - test - discuss (ARCHIPOLIS, p 9:3).

The extent to which the emphasis on reading and textbooks pervaded the elementary science program is illustrated by an episode observed in an elementary life science class where the teacher opened a recitation period with the question: How do we learn? A chorus of students replied: We learn by reading. Exactly the same liturgy was heard in another elementary school there (p 9:9).

Other than the fairly common practice of learning science by reading from a textbook series, the selection of what was to be read and the actual time spent on reading science varied greatly from teacher to teacher. In most of our school systems, no district-wide elementary science program was identified. (FALL RIVER, BRT, WESTERN CITY, RIVER ACRES, URBANVILLE.) The outstanding exception was ALTE.

A junior high principal in VORTEX whose career had been identified with science education commented on elementary school science (p 10:10):

> *Teachers are very uncomfortable with science. You really can't blame them. Personally, I think instruction in science should be left to the upper grades. About all you can ask for is solid preparation in reading, especially comprehension, and mathematics when they reach you in the junior high.*

Junior High Program. The middle and junior high school science programs operated at least somewhat more effectively than the elementary school science programs. As a rule the junior high schools were departmentalized with a teacher designated as a science teacher. The middle schools usually were not departmentalized and a teacher usually taught more than science. But in each there was a time scheduled for science courses. The general content of these courses can usually be inferred from the course titles, as the following chart shows.

SITE	GRADE 6	GRADE 7	GRADE 8	GRADE 9
ALTE		Life	Physical	
ARCHIPOLIS		Physical	Physical	Biology or Physical
GREATER BOSTON				
BRT	. Behavior & Intro to Bio-Elect-Astron	Bio	Earth/Chem	
FALL RIVER		Life	Earth	Physical
PINE CITY		Gen Sci	Bio	
RIVER ACRES	General	Life	Earth	
URBANVILLE		Bio (1 sem)	Physical (1 sem)	Oceanography or Earth (electives)
VORTEX		Life	Physical	Earth - Space
WESTERN CITY		ISCS	ISCS	

however, if the visitor read only the course catalogs and timetables, he/she was apt to get the wrong impression of these programs. As with the elementary science programs, what actually happened in the classroom was left to the discretion of the teacher. There was very little agreement (as perhaps there should not be) on what should be included in a junior high science course.

The philosophical orientation of the teacher played a key role in determining what content was taught and how it was taught. The junior high teaching ranks were composed of many former elementary teachers with a "whole child perspective" who had "moved up" and many "subject oriented" high school teachers who had "moved down" from or were waiting to "move up" to high school teaching. But according to our observations it would be incorrect to characterize most as oriented to another kind of school. Most teachers were focused on the special problems of this transition period between elementary and high school (ALTE p 3:34). How they approached these problems was largely a matter of individual choice on the part of the teachers. There was very little attempt to articulate courses with the many learnings different students have had in elementary school nor with what they would be expected to take in high school, though most teachers felt that more articulation should occur (RIVER ACRES, p 1:41).

OLD SCIENCE NEVER DIES

The three classes of levers, Ohm's Law, the five steps of scientific method, the electron shell model of the elements, the coefficient of friction, the coefficient of elasticity, converting pounds to slugs, the parts of the eye, the life cycle of the bean plant, the stages of mitosis, and the complete biological classification of a mosquito, an anthropoid, a pine tree, and Euglena have been in the school curriculum a long, long time--fifty years at least. Their centrality in the disciplines from which they came has waned considerably, as more general theoretical principles have been discovered. Yet, they were traditional elements to be learned--more for their extrinsic than intrinsic interest or value. Their existence in the curriculum was easily rationalized in terms of knowing what people are talking about when they refer to these things they studied in school. As one might suppose, the management of such traditional elements in the curriculum has long since been worked out to a fine precision.

However, for most of today's pupils, these classical topics appear dull and outdated --in contrast with the kind of science one picks up on "Star Trek" or "The Bionic Woman." Teachers sometimes blame television for the lack of interest students have in the basic scientific curriculum; they seldom delight in the new interests and excitement it has created in many areas of science: the space frontier, biological engineering, the environment, and psychology, for example. What do you do with the "tried and true" curriculum today's adults were exposed to and expect to have taught to today's youth? In most schools passing on the lore studied by the present adult generation was a prime responsibility. It could not be dismissed by calling attention to revolutionary developments in modern science and technology.

New Science Complicates. A fairly pervasive "non-trend" in CSSE science departments was adoption of laboratory-oriented NSF sponsored science curriculum projects--despite it being a sample of schools that in at least some ways demonstrated a willingness to consider

new things (allowing access to our case study project, for example). A review of the sites where physics projects were specifically mentioned will bear this out. A teacher in BRT taught PSSC once, liked it, but felt it was too "risky" to use with her present students (p 4:10). In VORTEX, the physics teachers used a modified version of PSSC for their "top" physics classes (p 10:9). A physics teacher in FALL RIVER taught PSSC for a few years, disliked it and discarded it in favor of Harvard Project Physics which was still in use part of the time (p 2:7). At one time PSSC was used in URBANVILLE, but Holt-Rinehart-Winston's Modern Physics was "now being tried and probably will be adopted" (p 5:5). The physics teacher in WESTERN CITY was using a combined version of PSSC and HPP (p 7:24) (but he was planning to leave teaching this year). In RIVER ACRES the physics teacher knew about the new physics curricula but rejected them (p 1:92). In PINE CITY Rob Walker felt that given the present resources, it would be out of the question for them to attempt to teach any of the NSF sponsored laboratory-oriented courses (p 6:23). The story would be similar for biology or chemistry.

Unlike the mathematics curriculum and teaching, the natural sciences are expected to be interesting to pupils. As indicated late in Chapter 12, many new topics have been introduced. At our CSSE schools we did not find a single credit course on "recreational mathematics," but we found a number of recreational science courses. We found ornamental horticulture, mushrooms of the local forests, nature walks, nature camps, photography, and an electronics course with an orientation to amateur radio, all carrying credit toward graduation, all rather comfortably.

In these schools we saw mathematics as very serious stuff. Science, however, was encouraged to support a lot of hobbies (though hobby clubs were less common than they had once been). Mainline science, of course, was serious stuff too, especially if well filled with traditional content.

One complication was how to decide whether these more peripheral science courses should be classified for college admissions. Are they laboratory science? Some high schools had solved this problem by requiring only one year of a laboratory science and leaving the recreational sorts of science courses as electives for students who were interested in them.

There are other problems with these courses. Recreational science though often a combination of traditional and newer science topics usually involved out-of-school activities; thus creating problems for the counselors and schedule makers. The courses cut across tracks or levels they generally pre-requisite. The classes had more heterogeneous student enrollment, though with interests aroused, this was often not a problem. They depended on special abilities and interests on the part of teachers, not at all guaranteed by the teacher-education or certification criteria. Recreational science complicated things for administrators (and teachers and parents) who like an orderly shop--but they seemed to enthuse teachers and students.

There are whole new sciences and brand new theories in science. Some of these had come into the schools. Oceanography, ecology, tectonic plates, and above all, molecular biology, are aspects of the new sciences that had entered the curriculum fairly widely, both in the form of separate new courses and as units, chapters, or special topics within traditional courses. Part of their interest may lie in their relevance to human life, nature, the planet Earth. At FALL RIVER and URBANVILLE new courses in ecology and marine

biology had been developed. At PINE CITY and ARCHIPOLIS ecological topics had found their way into older courses. In another of our sites, there was a new ecology course, and also a new, alternate high school with all science courses related to outdoor work. There the outdoor camping started in elementary grades and was continued on a larger and larger basis during junior high school years.

In RIVER ACRES a junior high school science department chairperson spoke of her enthusiasm for teaching tectonic plate theory. Most of the new-science innovations, like the recreational science courses, were started by teachers with particular interests in the topic in question. A district-wide outdoor education program in ALTE was strongly supported by administrators expressing a desire for all teachers to participate so they could see their pupils in different situations than in the classroom. There are some major switches in pupil competence from the classroom to the forest camp. In general, students' enthusiasm was high for outdoor and for "challenge" types of programs. (See also information about the "Walkabout" Program.*) ALTE (pp 3:49-54)

One observer watched a fifth grade class doing the arithmetic of menu planning for their forthcoming campout. There was none of the boredom characteristic of another arithmetic lesson in the same class in which the problems being worked were from a textbook. In the textbook, even the author's efforts to arouse students' interest were somewhat thwarted by the teacher's simplification. For example, astronomical distances on one page were converted to small numbers by crossing out zeros, in order to get the correct arithmetic operations without getting lost in the large number of zeros.

Not all of the schools studied showed imagination in expanding the curriculum in topical areas likely to interest children. In RIVER ACRES, WESTERN CITY, and VORTEX, there was very little of this expansion. At BRT there was some. In COLUMBUS the emergency topical expansion through television, radio and field trips quickly subsided into routine textbook science.

New science topics in the curriculum create problems for laboratory and demonstration work. Rarely are they suitable for the traditional formula of laboratory work: arrange material or equipment, observe phenomena, record phenomena (tables, graphs, drawings, etc.), interpret observations by answering questions. Working with structural models of molecules, studying eco-systems in the field, maintaining a balanced aquarium, developing film or prints, constructing an electronic circuit, etc. All lack the adaptability to the standard laboratory format that the old science topics fit. If the format changes to accommodate these interests, then where is the rigor of scientific method?

The teacher of secondary school science is likely to take the traditional formulations of method more seriously than the university science professor. Although new science programs have introduced topics which call on the theoretical imagination more

*Maurice Gibbons, "Walkabout: Searching for the Right Passage From Childhood and School," Phi Delta Kappan 55 (May 1964): 596-602.

than they do on empirical observation, they have not always been accompanied by a clean rationale -- the (or a) method of science. For example, one of the frequent complaints against the Chemical Bond Approach, still heard in some of our sites, was that it violated scientific method by presenting theoretical models before it presented data that supported it. This problem is not likely to go away, with the demise of the CBA. University chemistry courses have increasingly adopted much of the CBA approach and dropped required laboratory work. (High school CBA chemistry may have simply been an idea two decades ahead of its time.)

SCIENCE ARTICULATION

It is not at all a new observation that teachers complain about the lack of preparation their students received in earlier grades. Secondary school science teachers complained to our field observers that elementary schools are so busy teaching children how to observe that they don't teach them much content. This was not fully supported by our observations in elementary schools, but probably reflects the purpose secondary school science teachers felt to cover both old and new subject matter. This pressure arises from the kinds of concerns we have already mentioned to make science interesting and to preserve the traditional content and method, but also from the increasing amount of content covered in undergraduate science courses at universities and colleges in which the teachers were enrolled. It involved them also in an upward articulation effort (see Chapter 14 for more on articulation), to prepare those students who are going to take science in college or university for the obligations they will encounter there.

One explicit expression of the upward articulation of high school to college science is the attention given to advance placement courses. Teachers and department heads in most of our CSSE high schools pointed with pride to the courses by which some students hoped to "proficiency out of" four to six hours of college chemistry, biology or even physics. Even if they fail the proficiency tests, the students taking such courses have the advantage of having covered the material once already thus making it more familiar and less of a strain to learn.

We do not know of college professors who encourage this, but it is clear that parents of "college bound" students often do. Inevitably, it seemed, mainline science in both secondary schools and colleges was becoming less reflective and more a matter of information storage and retrieval. This judgment might seem to be running counter to the strong increase in theoretical elements such as molecular biology, chemical bonding orbitals, and tectonic plate movements. These are prime examples of theory intended to provide explanations of the myriads of descriptions of forms and processes of traditional biology, chemistry, and geology. However, unlike the theory of mechanics or electricity, the connections they have with data observable in the high school laboratory are much weaker, if not totally beyond the reach of standard algorithms. More heuristic thinking is required in such theoretical models. Written descriptions of data and arguments supporting these theoretical elements are not only difficult to provide, for they too are shot through with theory, but increasingly are omitted altogether in favor of authoritative statements that scientists have collected data which support these

ideas. This is not a new problem, as Wagenschein* noted in connection with what he called the "Copernican Slogan"--the earth is a planet that revolves around the sun--a statement accepted without question by most people without their being able to give any evidence at all to support it.

Articulation with mathematics continued to be a problem for physical science teachers. It was not just that students did not know how to do ratio and proportion or to solve simple algebraic equations when they put in the context of physical quantities and real apparatus. It was also that increasing use was made of mechanical ways of routinizing the operations, e.g., the cancellation of units in quantitative chemistry problems, the use of formulas that link the quantities in a verbally stated problem, the use of slide rules or calculators. These were all ways of getting science problems solved without thinking through the mathematical ideas involved. The more theoretically oriented mathematics textbooks did not help this problem, because science teachers were generally even more likely than mathematics teachers to put aside the niceties of mathematics.

In summary, the content of the natural sciences taught in schools was increasing in scope and theoretical level, creating problems that appeared not to have been dealt with adequately by curriculum developers, administrators, or teacher educators. Mainly, these problems were being worked out as best they could by teachers--with limited help from science supervisors. However, when teachers talked to us about these problems they said they found no one very willing to listen.

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*Martin Wagenschein, "Wissenschafts-Verstandigkeit," Neue Sammlung 15, no. 4 (1975): 315-327.

Scenario Z. We found a variety of responses of high school youngsters to the science program. Some approved an elitist viewpoint, some wanted a more vocational orientation, some were bored, others expressed--as would be expected--a concern about their own abilities to understand things. We wanted to get a response from school people regarding these student perspectives so we created one of our scenarios around snippets of conversation we heard at the various sites. Then we used the mood of this conversation as background for asking questions about scientific literacy, proficiency diplomas and the role counselors play in steering students toward or away from science. We presented this scenario to high school science teachers, high school counselors, and high school seniors, and got responses as indicated on the following pages:

Scenario Z

Four ninth grade biology students waiting for the afternoon bus:

Ann: Sure it would be fun to be doing something, but lots of kids don't want to dissect frogs.

John: Ridiculous!

Laurie: I can't stand killing insects and pinching them to a board.

Tania: Next week we're going to watch plants grow. What do we do while we wait?

Laurie: Probably bookwork.

Tania: More hassles! There's not enough time to study at school. And they won't let you check the books out, so I can't study at home. So I flunk. Biology is too hard. It should be at the tenth grade.

John: There should be better "filtration." Not everybody should be allowed in the course. If you're going to take biology you gotta be willing to work.

Ann: That's what Mr. Mueller says. He says when we get to physics we will really have a good class because only the best students will be there.

Tania: But that's why it's so hard. My courses are too hard already. The kids who don't want to study have already gone into Art and Psychology.

John: Dumbhead courses!

Laurie: In seventh grade all the kids are mixed together in a big group, and then it splits--like that "mitosis" stuff, y'know.

Tania: Well, I want to be an obstetrician. I'd like to study birth and everything and sex education. You know, films and that sort of thing. Just reading from a book you don't get enough information. They use all those humungus words, all that Latin! Yuk!

Scenario Z

1. Are the feelings expressed here typical of opinions held by students in your first-year biology classes? (If not how are they different?)

Number Sampled	Returned Questionnaire	Omitted Item		Said "yes"	Said "no"
375	375	18	Of 357 High School Seniors	65%	35%
87	46	4	Of 42 High School Counselors	43%	48%
150	101	8	Of 93 High School Science Teachers	63%	31%

Among those who said "no" the following differences were noted:

A student in South Meriden, Connecticut: Kids don't really care about what they're learning. They are just worried about passing.

A student in Gordon Road, Georgia: In my first year biology class the feelings were good.

A teacher in Medfield, Massachusetts: They (our students) have been motivated in Grades 4-8.

A teacher in Perryman, Maryland: (We have) adequate study time in class; all students have a book; (and we have) numerous labs.

A counselor in Alma, Wisconsin: I have found that student attitudes about Biology vary with 1) their ability, 2) their motivation, and 3) their teacher.

2. What do you think is the principal cause of student dissatisfaction such as this? (Check one.)

	61 of 101 Teachers	39 of 46 Counslrs	264 of 375 Seniors
___boring lessions.....	8%	13%	31%
___insensitive teachers.....	10%	13%	3%
___incompetent teachers.....	3%	13%	6%
___their own immaturity.....	39%	28%	19%
___subject matter is irrelevant to student lives.....	20%	21%	21%
___unrealistic assignments.....	5%	5%	6%
___inadequate books.....	0%	0%	3%
___inadequate lab equipment and supplies.....	3%	8%	5%
___it's just talk; they aren't really distressed.....	12%	0%	6%

Scenario Z

3. Are there some important changes that could be made in science courses so that such students would like them more and get more out of them? What changes?

More lab opportunities were mentioned as important by a large number of students, counselors, and teachers. Among other comments our respondents made were:

From a counselor in Ensign, Michigan: Be more careful in explaining how this info (Science) applies to their everyday lives.

From a science teacher in Lynn, Massachusetts: Greater emphasis on lab work and the thought process associated with them.

From a counselor in Cedarhurst, Pennsylvania: Relate science to the real world. Integrate theory with reality. Science must live and the ability to apply principles is most important. Sometimes material is meaningless because students never see how theory will be used.

From a student in Newport News, Virginia: Yes. I feel that students learn more by experiments, films, and talking in class. There should be more of this done and not so much reading because the books do get boring.

From a counselor in Mesa, Arizona: Use different levels of difficulty. Our science classes are having good results with this type of scheduling on different levels.

From a student in Poway, California: Make the class more interesting.

Think about how those students at the bus stop were talking. Think about how students you know talk about science courses. Then answer these questions:

4. Are science courses in your school too difficult?

Number Sampled	Returned Questionnaire		Checked "yes"	Checked "no"	Checked "other"
390	375	of 373 High School Seniors	13%	73%	14%
87	46	of 44 High School Counselors	15%	72%	13%
150	101	of 100 High School Science Teachers	9%	87%	3%

5. In science courses in your school, is the balance between lab or project work and textbook work about right?

	of 99 Teachers	of 46 Counselors	of 370 Seniors
Checked "yes"	64%	50%	56%
Checked "no, we need more lab work & projects."	34%	48%	41%
Checked "no, we need more textbook work."	0%	0%	3%

Scenario Z

6. Do you feel your school should be offering more science courses designed for the "below average" student?

	Checked "yes"	Checked "no"	Checked "I don't know"
of 372 High School Seniors	45%	34%	22%
of 46 High School Counselors	47%	51%	2%
of 100 High School Science Teachers	50%	46%	4%

7. Is it more difficult for students to get good grades in science than in most other subjects in your school?

	Checked "yes"	Checked "no"	Checked "I don't know"
of 371 High School Seniors	38%	45%	17%
of 46 High School Counselors	37%	61%	2%
of 99 High School Science Teachers	36%	51%	12%

8. Do you believe that a major effort should be made to raise the "scientific literacy" of young people?

	Checked "yes"	Checked "no"	Checked "I don't know"
of 372 High School Seniors	61%	18%	20%
of 46 High School Counselors	76%	11%	11%
of 101 High School Science Teachers	96%	4%	0%

9. Should school districts set some minimum competency in science for all students to obtain in order to graduate from high school?

	Checked "yes"	Checked "no"	Checked "I don't know"
of 372 High School Seniors	51%	37%	12%
of 46 High School Counselors	61%	24%	11%
of 101 High School Science Teachers	69%	16%	15%

10. Are junior and senior science courses in your school aimed primarily at the students who will be going on to college?

	Checked "yes"	Checked "no"	Checked "I don't know"
of 373 High School Seniors	73%	15%	12%
of 46 High School Counselors	74%	20%	0%
of 100 High School Science Teachers	71%	27%	1%

11. Do science teachers in your school seem to want mostly to teach "pure" science rather than about how science is used in everyday life?

	Checked "yes"	Checked "no"	Checked "I don't know"
of 365 High School Seniors	48%	34%	16%
of 45 High School Counselors	38%	42%	11%
of 99 High School Science Teachers	34%	52%	13%

Scenario Z

12. Do school counselors discourage students from taking science electives?

	Checked "yes"	Checked "no"	Checked "I don't know"
of 368 High School Seniors	3%	78%	19%
of 44 High School Counselors	2%	94%	0%
of 99 High School Science Teachers	12%	69%	17%

The percents above are based on those who responded to the item. Results have not been weighted according to sampling plan because the groups were drawn in different ways.

Our interest in this scenario was primarily in the perceptions students had of the relevance of biology, the elitism of science courses, and the sometime incompatibility between laboratory work and personal and classroom demands. Students attributed student dissatisfaction to "boring" instruction and its lack of relevance, but teachers and counselors attributed it more to immaturity and caprice of the students. One science teacher in six, one science student in five, and one counselor in four did question the relevance of their biology instruction.

We did not find support here for a finding of exclusionary elitism. The respondents did see science as for the college-oriented and needing some minimum proficiency standards, but they believed that counselors and teachers were not trying to keep the courses "exclusive." Yet need was seen for a major effort to raise the "scientific literacy" of all young people. They did not see the teaching or grading as too difficult, or more so than in other high school subjects. They seemed to see science courses as special, and worthy of student respect, perhaps even awe, not satisfying an important student fulfillment, yet not exclusionary.

There is a bit of inconsistency here, if one believes that teachers can teach about any science idea or problem at several levels of difficulty, setting standards with regard to education the individual youngsters are getting rather than with regard to the intricacies (particularly quantitative) of the subject matter. But these respondents and others we interviewed appeared to believe that the subject matter is fixed and the tests are fixed, and that the curriculum department and teacher have little choice except between "the real thing" and "the watered down version." Science exists; science is difficult; therefore it doesn't make sense to complain that it is too difficult. To teach pre-college material, to emphasize mathematical problems, to have numerous prerequisites, and to have high standards appears not to be arbitrary and inconsiderate, but responsible. The inconsistency goes away.

We did find the teachers and others about the schools persuaded that there are "basics" in science--the main terms, concepts, relationships and problems central to the high school courses of a generation back and central to the introductory college courses of the day. What should be taught was something rather precious, not to be fooled with, not to be left to students, not to be decided by popular vote or with respect to its functional utility. Parents, youngsters, and even teachers, for the most part did not feel that they were denied consideration if they were not asked about what the courses should cover--in fact, they considered the question pretentious. They saw the science community as having long ago determined what the bases of science are, and the political community living up to its present responsibility when it declares certain of those learnings to be requirements for high school graduation.

The science curriculum of the schools was--in operation more than by definition--taken to be a set of knowledges and skills, rooted in the academic disciplines. It was to be shared in common by all students who would undertake the study of science. Though it may emphasize conviction in one classroom and skepticism in another, it was to be seen as belonging to the collective wisdom of men, a part of the culture, a property that exists outside the individual learner.

As seen by most people in the schools, science education has no more alliance with mathematics education and social studies education that it has with English education. Science was seen by many to be the subject matter of physics, chemistry, and biology, and perhaps astronomy, botany or geology, sometimes mixed together as general science.

These were seen as fundamentally different from the things taught by teachers of mathematics (even though many science teachers were forced to re-teach arithmetic and algebraic operations) or teachers of social studies. With a few exceptions, primarily in environmental education, there were essentially no interdisciplinary efforts in the sites we studied.

The circumstances varied from place to place depending on teacher personality, parent interest, and many other things. Although we found a few elementary school teachers with strong interest and understanding of science, the number was insufficient to suggest that even half of the nation's youngsters will have a single elementary school year in which their teacher will give science a substantial share of the curriculum and do a good job teaching it. A general science course was a standard offering in junior high schools at our CSSE sites. We saw an outstanding one in an open school in VORTEX.

Most high school science departments were offering biology for all students and either chemistry or physics or both for the student going to college. Laboratory work in several sites appeared to be diminishing in importance because of expense, vandalism, and other control problems, and the emphasis on course outcomes that will show up on tests. Some science courses at each site appeared to be well planned and well taught.

Mathematics

ELEMENTARY SCHOOL

In the eleven districts of the CSSE study we found little evidence of "new math" sets, hands-on materials, or area and slope models of multiplication and division. Instead, various forms of pencil-and-paper mathematics dominated the scene in the elementary schools. Materials such as those generated by new math curriculum projects (ESI, Dienes, Cuisenaire and math labs promoted under the British infant school influence) which schools had acquired earlier had either disappeared or were no longer used.

In one school in the ALTE district, the "Mini-computer" method of addition and subtraction developed by the Papys from Belgium for CEMREL's math project was being used. Interestingly, it is also a paper-and-pencil method despite being a major conceptual innovation using the binary system to represent decimal numbers. If teachers (and parents) respond favorably to such a system, use of paper-and-pencil conceptual systems might spread to higher grades and be adopted by other schools. However, it appeared to the CSSE staff that teachers and parents were much more interested in innovation at the early grade levels than at the upper grades.

A teacher in RIVER ACRES (p 1:34), who had nine years of teaching experience, commented that

> *You might as well forget about teaching conceptual mathematics to 75% of the children in elementary school. The upper level children like it. The rest are not only bored--they hate it!*

It is clearly mental discipline that is the focus of the vast majority of teachers of mathematics at all levels beyond the second grade, and even some kindergarten and first grade teachers would agree with this focus:

> *The emphasis on process may be an emphasis on explication--to ask a student to explain how she/he arrived at a solution, even a right solution, may be only indirectly related to mathematical skill or conceptualization. If the emphasis of elementary mathematics is on computation, it might be argued that the successful employment of "number facts" requires, at minimum, a recognition of mathematic symbols which order certain facts to be used. That this recognition is largely reflexive, as is a child's response to a red stop signal, argues not so much against the possibility that the reactor has not the knowledge of the meaning of the signal, but more toward the possibility that in familiar situations, no reflection on the meaning is necessary; it is sufficient and appropriate to stop--or in our situation to sum, to divide. To ask a student, who is behaving appropriately, to explain his or her behavior is unusual, unexpected, and unsettling.*

One comment we heard repeatedly was that no matter how hard teachers at each level try to prepare students for the next level, teachers at that level complain that the students are not well prepared. The complaints were made by math teachers at all levels--college through elementary.

A second grade teacher said:

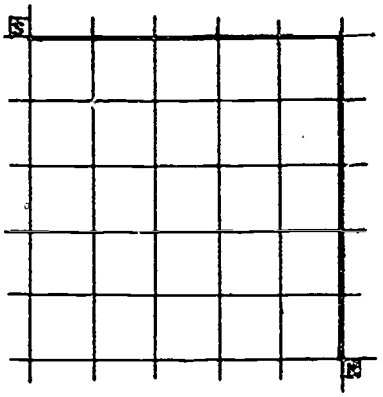
> *Many of these children can't remember simple number facts, like 3 + 2 = 5, but have to put down 3 dots, 2 dots, and count them all. The attachment to this method is going to prevent their making good progress.*

A third grade teacher in a school of mostly above average students reported near the end of the year that many children still had difficulties dealing with quantities larger or more complex than those they could easily visualize with the concrete materials she had used to illustrate the principles of measuring length and adding common fractions. Thus, they could add 1 1/2" with 2 1/4" but couldn't add 11 1/2' with 6 1/4', or 2 3/8" with 1 7/8". Multiplying 22 x 30 proved difficult for many children it seemed because they could not add up that many 22's or that many 30's. Six times thirty could be managed by adding six 30's, but 60 x 40 could not, even when the participant-observer, working as a teacher's aide, suggested counting by tens Counting by tens past 100 was difficult, and that student had no idea what came after 200, when counting by 10's. The conceptual leap from concrete procedures to the general idea seemed to be one many elementary school children fail to make on their own. Teachers too often seemed unable to help children make a necessary conceptual leap.

Fun and excitement--the aesthetic approach discussed in Chapter 12 in the section on understanding--seemed to be absent from almost all elementary mathematics classes. The efforts textbook authors have made to insert challenging and interesting puzzles, problems, and topics seemed to come to no avail--with the priority of most teachers on the basic task of mastery of fundamental operations. For example:

> when a participant-observer was serving as a teacher's aide in a high-level fourth grade math class, many of the students were doing long division. They had already successfully completed multiplication with two-digit multipliers, which seemed to be an official pre-prerequisite for starting on long division even though long vision only requires multiplication with one-digit multipliers.

Several students had come to the temporary aide to get their answers checked. When they were correct, he pointed to a problem in a box in the center of the page on which they were working. None of the students tried it. It showed a map like that at the right with the route a student took from home to school and back marked out like the one shown. The question was whether a shorter route could be found. All were sure that there were many shorter routes and they proceeded to mark off several zig-zag routes between the student's house and the school. When asked to prove their routes were shorter than the one marked in the book, the students were somewhat at a loss. To them it was obvious their routes were shorter. The "aide" took them to the chalk board and offered a proof that a particular zig-zag route was just as long as the route with only one turn. This involved dividing the one-turn route into segment one block long as shown. Some students were sure the "aide" had counte rong, and much discussion ensued which attracted several other students.



As the students left for lunch, they were debating the problem, and the teacher came over to see what the excitement was about. He explained to the visitor that they never had time to do the problems in the boxes on the textbook pages, having to concentrate on the numerical exercises that filled the rest of the pages. He seemed almost not to believe that the problems like this one in the boxes were really mathematics.

What teachers at various educational levels consider to be mathematics is an interesting question. Helen Simon's site visit report (vignette p 12:11) on a fifth-grade class working on the "Peas and Particles" unit of the Elementary Science Study contained the observation that neither the teacher nor the students seemed to think that estimating in various ways the number of small objects filling a large container had anything to do with mathematics (or science, for that matter). It was seen as a challenging activity that had little to do with subject matter, "possibly social studies," one child suggested.

In elementary schools across the country we found little deviation from a traditional curriculum. Elementary school mathematics was primarily devoted to helping children learn to compute.

Articulation between elementary and secondary schools was said to be a problem everywhere. A RIVER ACRES elementary principal put it this way (p 1:38):

> *We treat them like children in the fifth and then after three summer months they become "students." Most elementary school teachers think they are there to help children with their learning mathematics and most junior high school teachers think they are there to impart mathematics to students who want it. Elementary school level 3 kids get taught where they*

are whereas junior high school level 3 kids get taught the same as level 2, only slower. What this ends up as is moving from slow achievement in the fifth grade to total failure in the sixth. The junior high school will say it is because they are having a tough time to adjust to junior high school. I say they aren't taught anymore. It's either them or us--one of us has to change.

JUNIOR HIGH SCHOOL

Our CSSE site visits indicated that the goal of junior high math was to prepare as many students as possible for the high school academic track math courses. As indicated in Chapters 12 and 15 the emphasis was on preparation and performance. This should not have surprised many junior high students because, as we saw it, the goal of most elementary school teachers was to get students to master arithmetic, a "necessary prerequisite" for pre-algebra courses in junior high school. A junior high school principal's view of the articulation problem was expressed to site visitors this way (transcribed from tape):

I have a lot of students coming in complaining about their seventh grade mathematics teachers. They say, "Those teachers up there don't know what they're doing. I know how to get the answer. I've got the answer. It's right on the paper. They're counting it wrong, and they're insisting I show all the steps.

And so we get into a counseling session. This is a math teacher. She's interested in processes. It's going to be that way from seventh grade on. You might as well get used to it.

And that's one of the toughest things our teachers do at the beginning of the seventh grade in math. I would argue that if you sat in our classrooms you'd probably see a considerable amount of emphasis on the process by which kids work through to get the solution and less emphasis on the solution. Whereas, if you took a broad perspective on elementary schools, they're not trained as mathematicians. They're not going to get into any algebra and are more interested in kids, in whatever way they can, figuring out the solution to the problem, with a little less emphasis on the process of communicating the process in written form.

In a very real way, I think it's the toughest change in terms of instruction that the kids will go through in their entire academic career, because it's the one point where the training background of the people involved in teaching them changes dramatically. From now on it becomes more and more specialized. Up until the seventh grade, you're dealing with generalists.

We felt that this distinction was part of the mythology of the two schools, and that the difference was more one of degree than one of kind, both emphasizing operations and right answers.

At each level, of course, there were exceptions. A junior high school principal (who had once been a junior high science teacher) commented to site visitors (transcribed from tape):

> *Another problem; we teach over and over some of the most inapplicable subjects, like operations on fractions. A week after the test they can't do it again. There's no way they're going to use it. Logarithms, algebraic equations, areas of triangles--the only time they see it is in the math class. The same with invert-and-multiply fractions to divide, least common multiples, lowest common denominators, etc. We'll never solve that problem because we do not apply mathematics enough. If we start with the things we use in life, we actually do things, how much paint, how much drapery, how much material for dresses, I'd hope that we'd begin with math problems that would have some use for the average student. There's thousands of things out there.*

In answer to our question, "When are they (students) ready to pick it up because they need it?" he said:

> *When I taught physical science, specific gravity, density, the math teacher was teaching ratio and proportion. The kids couldn't make the transfer when there was anything different. The same equations with x's and y's they could just crank them out. (But) when I'd give them the same problems the next period with s, g, and d, they're lost. If you put in the units of measurement, they're lost, and you'd have to convince them they're doing the same thing! And that's where I wondered, "What are we doing?"*

On another occasion the same principal told us about moving the subject matter lower in the grades:

> *Ever since Sputnik, we've been pushing down what I would call the college level math sequence--algebra, geometry, advanced algebra, senior math, calculus. When we decided to emphasize math, the intent was to push those concepts and the understanding of that sophisticated abstraction down lower, and lower and lower, and lower. Again, I think, for most kids, that was a terrible mistake, because I don't think that mentally and maturation-wise, in terms of their cognitive development, many kids at the seventh grade can handle it. They can't handle it. If they can, they have to struggle with it. Only a very limited number--even in selected populations--is it easy for.*

In our national survey we asked junior high school mathematics teachers and elementary school mathematics curriculum supervisors about things that were wrong with the mathematics courses in their schools. They were allowed to check as many things in our list as they wished. The results were as follows:

	Elem Supr's	Jr High Tchrs
__students have been promoted without knowing basic mathematics	59%	92%
__too little emphasis given the the "big ideas" of mathematics	29%	14%
__too little attention to the "logic" students use to get wrong answers	58%	34%
__the curriculum under-emphasizes the basic skills	31%	60%
__the public and administrators are pushing for the wrong things	8%	17%
__too little attention is given the individual student as a person	20%	43%
__too little help is available to the teacher with teaching problems	25%	19%
__class periods are too short, classes too large	25%	26%
__textbooks or workbooks for basic math inadequate for older students	8%	27%

Of 150 junior high math teachers sampled, 80 returned questionnaires and responded to this item above. Of 198 elementary supervisors sampled, 112 returned questionnaires and responded to this item. The percents are weighted to estimate the national return based on those who responded to this item. Standard errors in Chapter 18.

The most apparent concern expressed by these mathematics educators was about the preparation of students in the basic skills. There was only a small expression of concern about pressure from administrators and parents, the quality of support services for teachers having teaching problems, and for the instructional materials for older students in remedial classes (a plea heard early in our visits). Elementary supervisors (many of whom were also principals or teachers) appeared more concerned about the present understanding of mathematical ideas whereas junior high teachers appeared more concerned about the present level of computation skills and more concerned about the need for dealing with the individual student as a person. These responses were largely consistent with the case study reports prepared by the observers. Perhaps the largest surprise was the high level of interest expressed here in the logic of students who are getting wrong answers.

Most of the time in the field when our observers talked to teachers and others they did talk about problems. All in all the teachers, administrators and supervisors thought that a pretty good job was being done, given the circumstances. Few parents felt that they should have been teaching for other objectives than they were.

HIGH SCHOOL

In most of our sites we found secondary school mathematics to be just as traditional and work-oriented as learning to compute in the elementary school. The judgment from mathematicians and other visiting site observers was that many of the courses were tedious. Several noted however that the students in high school mathematics classes did not appear to find them as dull, uninspiring, and irrelevant as the observers did. Teachers and students appeared to accept mathematics as a dry mechanical thing, to be done stoically. Most students took as much math as they needed as pre-requisites for the other courses, e.g., for the science courses they needed for their college major or vocational choice. It appeared obvious and acceptable to most people that the justification of the traditional high school mathematics content (algebra, geometry, trigonometry, and their continuation into analytic geometry and calculus) is that these topics prepare the student for engineering, physics, economics, statistics, and other "mainline" applications of mathematics in the world. In this sense, mathematics was a pre-vocational subject for many promising students. That mathematic experiences could be of value for other purposes seemed less important--though remedial courses and proficiency tests were treated as general education requirements.

A math teacher will tell you that the beauty, elegance, and even humor in mathematics comes from the familiarity one has with ordinary patterns--which permit recognition of interesting and unexpected deviations (see PINE CITY, p 6:36). The sophisticated teaching of mathematics in secondary schools was probably best developed in ALTE, where everything was oriented upward, toward the culminating calculus course, and teachers were geared to getting students to solve as many problems as they could. The students appeared to work hard there, yet their teachers complained in a departmental meeting that there had been a big slump in student motivation during the past ten years. They spoke

of several individuals who were asking for so much (unnecessary) help that the teachers had had to ask them to start trying a little harder.

The most skillful high school mathematics teachers we observed seemed to spend their energies guiding students to solutions to set problems, much as a good tutor helps a single student solve problems assigned by the teacher. Rob Walker observed an able algebra teacher in PINE CITY. This is how he described part of the class procedure (p 6:36):

> Each student describes his/her approach to the problem and talks his/her way through the solution step-by-step. Obviously this is something they are used to doing and they talk easily and confidently about denominators, quotients, factors and terms. All the descriptions are accurate and precise and used with economy. Mr. Williams lets errors pass and tries to get the class to discover them:
>
> > "I don't understand how that can be," Jane comments on a student's solution. "How do they cancel out?"
> >
> > "Good question," adds Mr. Williams, "can you cancel from numerator to numerator? No? Right."
> >
> > "So his answer's wrong?" Jane asks.
> >
> > "Correct."

Such teaching for understanding obviously takes great pedagogical skill and mastery of the teaching materials. Those having this skill walked around a room of 20-35 hard-working students helping them discover how to attack and solve the particular problems on which they were working. With some students lazy, disinterested, or even rebellious, the problem became even more difficult, even to such an extent that the difficulty of the problems to be solved was reduced in order to keep order. (See Hassler Whitney's descriptions of students working on problems in high school math classes, to understand what the typical teacher is up against, p 16:2.)

We asked the senior students in our national sample what they considered the one thing most wrong about the mathematics courses they had taken. The number responding was 318. Using percents weighted according to the RTI sampling plan we found that:

31% checked that "the courses were boring,"
26% checked that "the courses were too much aimed at the 'bright kids,'"
14% checked that there was "not enough lab and project work,"
13% checked that they "overemphasized facts and memorization,"
12% checked that "the courses were impractical," and
5% checked that the "books and equipment were inadequate."

We also asked them what they considered the one thing most right about those math courses. The number responding was 341. We found that

40% checked that (the courses) "stressed the basic facts,"
19% checked that "they stressed fundamental ideas,"
13% checked that "classes have been small,"
12% checked that "the courses were interesting,"
9% checked that "the courses were 'down to earth,'" and
7% checked that the "books and equipment were very good."

Clearly what the students liked best about these math courses was that they stressed the "basic facts," though a small percent felt that overemphasized. It was interesting that the best thing that 13% of the youngsters could say about them (of the choices we allowed them) was that the classes had been small. The quality of books and equipment did not draw many comments. Over half of the youngsters responding found the courses boring or elitist.

We compared these responses to those made by the same youngsters with regard to their science courses (presented on page 13:5). We found the youngsters, not surprisingly, more concerned about the quality of their books and equipment in science than in math. There were fewer concerned about an "overemphasis on facts and memorization" in math than they were in science, more satisfied with the emphasis on facts and memorization they found in math. More found the science courses interesting.

When a teacher and a selected group of students from an alternative high school discussed their courses with a team of site visitors, they remarked that they had not been able to find a way to make mathematics relevant to student interest in their environment. The school was filled with projects involving crafts, oversized terraria, a herbarium, dissected animals, mounted animals and skeletons and records of bird migrations. One of the visitors suggested D'Arcy Wentworth Thompson's work on Growth and Form and described briefly how it could be applied to comparison of skulls they had prepared. It was clear from their responses, however, that this was not regarded as "mathematics." They felt they needed mathematics as future citizens, even though they had found no environmental application for the algebra and geometry they were studying. They found themselves hard pressed to defend a need for math--except that it was a sometimes useful proof that they were not escaping from the hard reality of school.

Unlike the sciences, where new topics often evoked considerable interest, almost the only topics for school mathematics that ever entered any discussions of ways of varying mathematics offerings were statistics, computer math, and "applied mathematics." Only the last offering was said to have a chance of full enrollment.

Many math teachers were popular teachers. At FALL RIVER, for example (p 2:10):

> Mr. Bennett is a veteran in math education, yet he still loves to teach geometry because it is a tough subject and he enjoys helping kids struggle and finally grasp it. Students speak fondly of him, yet respect his toughness.

We were convinced that getting tough, driving students to do more problems, often sets the norm of the "good math teacher." One math department chairman of a large urban high school remarked, "What I tell all my classes is this: the only practical value you'll get out of studying mathematics is to learn to do as you're told." (See Chapter 16 for further discussion of mathematics for moral training.)

The goal of high school mathematics seemed to be to get as many students as possible ready for college math, or even, as in advanced placement courses, to get them ready to enter more advanced college math courses. If they would have to take the same course over in college, then this would prepare them to make a superior grade.

Social Studies

Student response to social studies was widely observed to be apathetic. A teacher at BRT observed that "the kids look on it as not really necessary." A parent at BRT (p 4:4) said:

> *The knowledgeability of students about world and state affairs affects their response to its study. They know more about social studies than about science. So they feel they don't need social studies. This is to their credit, I think.*

Yet, half the seniors surveyed reported that their social studies courses had been interesting.

It was clear that the student had many sources of information about current social events and issues and that the school was not the most effective or pervasive source. The following classroom incident in BRT (p 4:46) suggested, however, that the apathy was not solely a matter of satiation.

Teacher: *How many heard the Ford-Carter debates last night?*

Student: *I watched 'em come on and go off and slept during the rest.*

Student: *Boring.*

Student: *The best part is when the sound went off.*

Teacher: *Don't you think there's much to be said for enlightened citizenry?*

Student: *I don't want to know that bad.*

Another indicator of low student interest in social studies was the relatively low enrollments found in the elective courses. The enrollments seemed to reflect a filling out of one's schedule to obtain required Carnegie Units more than an interest in the content. Some felt a lack of purpose and definition contributed to unfavorable student attitudes toward the social studies. To many it appeared that there was much redundancy in the material. The response of a teacher in BRT (p 4:42) was not atypical:

> *We had this film the other day in sociology. . . a good film on the race issue. The class didn't want to discuss it. I could see them shrinking--"Oh no, not that again".*

Occasionally we found a spirited or challenging social studies class. A junior class (Advanced Placement) in VORTEX (p 10;8) discussed the "assimilation" of cultures.

> A Jewish student was presenting a report on the experiences of his people. Parts of it touched on the policies of Adolf Hitler. As the paper concluded, a classmate referred to a ") Minutes" episode the previous Sunday regarding the American Nazi Party. An interesting, dynamic period ensued, but was brought to a rather abrupt close by the instructor.

Teachers were concerned about spending too much time away from the assigned lesson--as happened so easily for competent social studies teachers. One teacher explained her abrupt action:

> *I literally don't know how to balance off current social affairs with the need to cover material. They often introduce fine examples from televised programs, yet I know that the (advanced placement) exams are heavy on content coverage.*

We asked the senior students in our national sample what they considered the one thing most wrong about the social studies courses they had taken in high school. The number of responses was 325. (The following percents were weighted according to the RTI sampling plan.) We found that:

40% checked that the courses "overemphasized facts and memorization,"
27% checked that "the courses were boring,"
11% checked that "books and equipment were inadequate,"
10% checked that there was "not enough lab and project work,"
9% checked that "the courses were impractical," and
2% checked that the courses were "too much aimed at the 'bright' kids."

We also asked them what they considered the one thing most right about these social studies courses. The number of responses was 340. We found that:

50% checked that "the courses were interesting,"
28% checked that "they stressed the basic facts,"
8% checked that "the courses were 'down to earth',"
7% checked that "they stressed fundamental ideas,"
6% checked that "the classes have been small," and
2% checked that "books and equipment were very good."

What the students clearly liked about social studies courses was their ability to hold interest. They were more impressed with their coverage of basic facts than they were with their presentation of fundamental ideas, but a very large number found the emphasis on facts and memorization the most objectionable thing about them.

When we compared the responses of these same students to courses in science and math we concluded that the social studies courses were capable of interesting the students more, but often failed to do so. The mathematics courses were clearly seen as more elitist.

In none of the three subject matters was there much praise for fundamental ideas. That could be because there was not much talk about it or that the students did not see this as a very important thing for a high school class to do.

We had heard that students wanted their subject matter to be relevant--at least we used to--but we found that courses in these three curricular areas were neither cited for being down-to-earth nor for being impractical. We believe that "relevance" was not a very high priority criterion for students for assessing the quality of courses in science, math and social studies.

We wondered how the students felt about how the social studies courses could be improved. On our national survey we asked 375 seniors, 250 of their parents and 150 of their teachers the following question:

> As you look at social studies courses in your high school and elsewhere, you probably see things that concern you. Please check those things below that you consider to be major problems. (Check as many as you wish.)
>
> (361 seniors, 148 parents, and 83 teachers responded to this item.)

Srs	Prnts	Tchrs	
47%	22%	33%	___too much emphasis on facts, not enough on concepts
13%	22%	24%	___too much emphasis on concepts, not enough on facts
12%	10%	8%	___too much emphasis on teaching about personal values
34%	33%	31%	___not enough emphasis on teaching about personal values
21%	32%	15%	___not enough qualified teachers
29%	15%	23%	___belief that teachers teaching the same course should teach the same things

Wondering how much the problems were affected by the lack of funds we asked the same people another question:

> In what ways have budget cuts in your district seriously affected the social studies curriculum? (Check one or more)

Srs	Prnts	Tchrs	
19%	23%	25%	___We have not had budget cuts recently
29%	28%	27%	___The social studies curriculum has not been seriously affected in any way
21%	20%	33%	___Classes have been made larger in size
10%	12%	10%	___Needed and highly qualified teachers have been "let go" and not replaced
30%	20%	29%	___We have more teaching from textbooks, less with material or in the field
8%	5%	10%	___No longer can we provide a textbook for each student individually
3%	1%	11%	___The inservice training program has been cut back substantially
9%	12%	12%	___Other: (Please indicate)

(The percents for both of the items above were not weighted. Standard errors are not available.)

Elementary. As a content area, social studies was found to be subordinate to reading and mathematics in the elementary curriculum. At each of the sites there was some kind of social studies curriculum, but teachers and principals readily admitted that instruction in this area was of much lower priority than reading and math. It had about the same

priority as instruction in science. Social studies lessons were seen to be given more time than science by most K-6 teachers perhaps because they were more knowledgeable about social studies than science.

Curricular materials in reading and language arts were often found to deal with social studies type content, e.g., stories about things like countries and people. Elementary teachers also devoted a considerable amount of time and effort to activities that were "social studies" in the sense of teaching social skills and attitudes. (See more on this in Chapters 16 and 14.)

The use of Man: A Course of Study was found only in ALTE*. A fifth grade teacher said, "I use it. I love it." But the pupils we talked to were bored with the emphasis on baboons, and did not seem to relate the learnings to personal values of humans. ALTE was also the only site in which some attempt had been made to develop and implement a coherent social studies curriculum in the elementary schools. Other sites had developed a sequence of elementary social studies courses as part of a district plan but had not insisted on or enforced its implementation.

Some of each curriculum was informal. At an ARCHIPOLIS elementary school, site visitor Bob Stake arrived just as a bake sale was closing. Sadly, he reported it was:

> . . . sold out, having earned money for the student council for awards for an already held social studies competition.
>
> The student scoring highest on a social studies quiz had won a $25 bond. Some quiz questions:
>
> *Who is our black member of the Supreme Court?*
> *Who found more than a hundred uses for the peanut?*
> *What black man assisted in the planning and design of our city?*
> *Describe the two statues in Jackson Park.*

Helen Simons, a curriculum evaluation specialist from England, included the following in her site visit report:

> I was curious to learn how social science was interpreted in an elementary school so I attached myself as a teacher aide to one fifth grade teacher. The teacher was reputed to be very interested in social studies--the nearest formal approximation on the timetable to social science. In the event we talked as much about science and math as social science. But that was the starting point.
>
> The teacher decided that I should talk to the grade about England. My introduction soon turned into an open class discussion. Questions flowed thick and fast from the advanced group as much as from the basic group. Topics included open space classrooms--advantages and disadvantages--("It's not so closed; if you get tired of the lesson you can switch on to another," etc.,)

*Our conclusion as to the infrequent use of MACOS was consistent with the findings of H. Russell Cort, Jr. and Nancy Peskowitz (A Longitudinal Study of Man: A Course of Study, Washington, D. C.: Antioch College, December 30, 1977). Implimentation problems and concern for controversy were not likely to be as much an obstacle as the fear that conventional subject matter would not be covered.

T.V. programmes--mostly adventure and humor (Monty Python scored highly), cars, sports, the National Health Service--this injected by the teacher--the Archbishop of Canterbury, Northern Ireland. I was impressed by their openness, their curiosity and persistence and the range of their knowledge. They told me that the war in Ireland was not only a civil but also a religious war. After I explained the National Health Service for a few minutes the boy on my left said, "So you have a socialist system there." Then one boy who had held up his hand patiently for ten minutes, it seemed, asked if I was still taking questions about cars?

"Sure."
"Well," he went on, "is it still true that people prefer Bentleys to Rolls Royces because the standard on the Bentleys is not so showy?"

There is no short answer. The discussion (dialogue?) which followed raised questions of values--which seemed not to satisfy John. After a few minutes the teacher broke in to suggest that he was really asking for a value judgment from me. . . .

Four children lingered for a moment when the lesson finished. I was looking at the teacher's book. One girl suddenly asked me:

girl 1 *"Does Queen Elizabeth tell you what to do?"*
reply *"What?" (In surprise, wondering if I had heard correctly.)*
girl 1 *"Does Queen Elizabeth tell you what to do?"*
reply *"Does Queen Elizabeth tell me what to do? . . . No, she doesn't. I listen to what she says but she doesn't tell me what to do."*
girl 1 *"Are you a teacher then?"*
reply *"Yes . . . I was."*
girl 2 *"Who's Queen Elizabeth?"*
girl 1 *"Queen of England."*
boy *"You should like her."*
reply *"Oh" . . . and they raced off to P.E.*

It was not only their forthrightness but their range of vocabulary (and in some instances, degree of understanding) which surprised me. Take the following comments on discipline from a fifth grade pupil.

"I don't see what parents and teachers can get out of discipline, you know. The kids will still do it whether you hit them or not. Like my parents, my Mom, she spanked me but she never hit me."

"Violence on TV has gotten everyone into violence, corporal punishment, you know, with the stick. How's it going to stop the kid? Just a little pain is not going to stop anybody you know. I never got that. I don't see how parents think they can get away with that . . . I don't see how anyone can get away with that."

"I'm for punishment--but capital punishment that's a big one out here. Do you have capital punishment . . . with the guillotine? . . . I'm for capital punishment. I believe that if you take someone's life that your life might be forfeited."

What interests me is the relationship between social confidence, pupil grouping and children's intellectual development. In such a supporting setting they can (and did) make mistakes, take risks and talk through their problems without fear of censure. The climate seemed very positive for growth . . . (but) the structure of the curriculum and speed of interaction did not seem to allow for much reflectiveness or accommodation to individual differences in stages and styles of learning.

Secondary. Social studies was observed to be an important curriculum area in the secondary schools. Little concern was expressed by secondary teachers regarding the teaching of social studies in the elementary schools. Only in ALTE did we find indication of sustained attempt to effect articulation from elementary to junior high school social studies. The bigger concern of secondary social studies teachers was whether the student could read. A counselor in RIVER ACRES said: "Every social studies learning problem is at base a reading problem" (p 1:74).

The importance of social studies in the secondary school was reflected by its being a required subject for much of the secondary experience. A social studies course was typically required at each year in junior high school. The course titles in junior high were typically geography (world or some region), U. S. History, civics, and state history. We saw no evidence of contact with the High School Geography Project, Project Social Studies, the Anthropology Project, DEEP, ISIS or other course content improvement projects. Occasionally we saw a unique course, such as the Local History course developed by the teachers at ARCHIPOLIS.

In Illinois the Illinois Office of Education was promoting social studies courses called "responsibility education." According to curriculum consultant Alan Lemke:

> *Responsibility Education* directs the sense of responsibility upon two of the most pervasive symptoms of modern social problems--citizen disinvolvement and the diffusion of responsibility. . . . Because no one understands or fully agrees with modern responses to street crimes, to school vandalism, to white collar crime, and to what is often perceived as loss of faith in government, citizens disinvolve themselves.*
>
> *. . .Responsibility Education responds to citizens' disinvolvement by perceiving choice and responsibility in the individual, a perception which partially justifies and generates the sense of responsibility. Police services, medical solutions to social problems, educational programs, and welfare programs should be the tools of individuals and not merely the results of technological advancements; and to bring social programs under the control of individuals, individual choice and responsibility are assumed as major premises in schools.*

We overheard no talk about "responsibility education" in our Illinois site, BRT, during the fifteen weeks observer Alan Peshkin was there.

One or two years of social studies coursework were found to be required in the senior high school (two more often than one in the CSSE sites). The most common course titles for the required courses were World History and U.S. History. Electives were offered with many different titles like Current Affairs, Modern Problems, Government, Economics, Anthropology, Psychology, Sociology, Latin America, European History, Political Philosophy, Religion, and Philosophy. The contrast between a history sequence and a science sequence was vividly portrayed in the ALTE case study.

The articulation of the social studies curriculum was found to be weak at all grade levels. A teacher in VORTEX observed that (p 10:8)

> *Unfortunately, social science is too often seen as a synonym for a collection of courses--often lacking a sequential development--a course here and a course there--with the belief that by offering such courses, the student learns once and for all.*

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*Alan Lemke and Sidney J. Slyman, "Responsibility Education: Rethinking the Teaching of Knowledge," (unpublished paper, 1977).

The field observer in RIVER ACRES could find no underlying and unifying principle in the social studies curriculum at that site.* The social studies curriculum in ALTE seemed to be an exception in that it was evident to the field observer that the curriculum was quite well articulated with the clear purpose of developing strong understandings in the history of mankind. Even here, however, a site visitor quoted a teacher as saying:

> He agreed that even social studies did not form an integrated area, but consisted of subject specialisms pursued independently, and only loosely held together by a very general definition.

SOCIAL STUDIES AS SOCIAL SCIENCE

Few were found who argued that the social studies curriculum was social science in the sense that it emphasizes a scientific approach to social issues. The methods of the social sciences and the tentative nature of bodies of knowledge called the social sciences were given little emphasis. Responses to an item on the CSSE national survey indicated that the lack of emphasis on social science in the social studies was consistent with the priorities of the general public. Sixty-six percent of respondents agreed with the claim that:

> The general public does not put high priority on teaching social studies in a way that emphasizes a scientific approach to studying social issues.

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*One of the very first reports we received back in Urbana from our field observers (FALL RIVER) was that the high school social studies classes seemed to be heavily staffed with coaches. We checked it out, there and elsewhere, and were not persuaded. Still the question in any curricular program as to the competition with competitive athletics is worthy of attention. In BRT, the jr. high school principal was also the social studies teacher and one of the coaches. He said: "I try to think of myself first as a teacher, second as a coach, although I will admit that during the season it's very hard to do. . . . This year it was worse because the things that have to be done with coaching have to be done now; and your classroom preparation time is what's left over." a RIVER ACRES social studies teacher surprised observer Terry Denny with an unsolicited comment on this competition (p 1:115):

> *The big ideas in social studies are not the most important; reading and writing are. But if you want to know what is really important look at the instructional budgets. What's important is athletics. They can ship kids by the buses to games, to contests, matches, whatever, because their instruction is important. We cannot take advantage of an opportunity when it pops up. When we ask for a trip for a class of students, the answer is no.*

On the other hand, there was a sense that social studies is taught as a science in the same way that chemistry, physics and biology are often taught. That is, a chemistry course in high school should teach what is known about chemistry, etc. The student then was expected to learn the facts about chemistry. The experiments were used to teach the facts rather than the process of finding out on one's own. Social studies was apparently most often taught in this same way. The content was conceived as what is known or factual. How the facts were obtained is secondary. Thus, there are five causes of World War I, the melting pot made America great, a bill becomes a law in this way, humans have primary and secondary needs, there is a law of supply and demand, and so on. It was commonly believed that in order to study the facts as temporary or arbitrary you first must have a mastery of the facts, and that was the job of the elementary and introductory courses.

The general public probably does not perceive social studies as science. The perception of the general public about what should be taught in social studies apparently was not much different from their perception of what should be taught in science. It was the exceptional teacher who wanted to run counter to this pressure. A site visitor, Frances Stevens, observed that most teachers viewed the emphasis of their teaching task to be "on the transmission of facts and skills."

Even the exceptional teacher seemed to make a distinction between social studies and social science. Site visitor Helen Simons, talked with a teacher who said:

> *I don't think I differentiate here. I think they overlap. I think. . . I guess social science would be concerned with teaching values. . . some important concepts about man and his environment whereas social studies is technically geography - rivers and their tributaries. . . and possibly. . . all geographical concepts like that I think I would classify that as social studies. But social science you really have to learn about living in a community and having values. That to me is a science.* [Where would she place History?]
>
> *I would say history is a social science too. You know why? Because if you are smart and you realize what mistakes other civilizations have made and you really try to avoid making the same mistakes that is a science. . . our values come in there. . . I think they (children) get values as you talk about these things (mistakes of other civilizations, differences in generations, etc.,) but you have to talk to these children . . . I have a big chance to talk to them when they are out playing, I watch their reactions with one another. I think that's social science too -- getting along with one another. And anything the guidance counsellor does with them is social science, too.* *(see also p 16:18)*

There is much potential for controversy in social studies--yet little controversy was found. The apparently dominant point of view was expressed by a FALL RIVER (p 2:13) teacher:

> *Teachers are an extension of the parent and as such should teach the value system that is consistent with the community. The community has a vested interest in the schools and has a*

> *right to demand that certain values should be taught and certain others not be taught.*

The word "truth" might be inserted for "values" in the quote. There were rare exceptions. A BRT (p 4:51) teacher said:

> *I've been accused of being a communist and an atheist. Once the science teacher and I brought two classes together to discuss Darwin. We were studying the twenties in history and talking about the Scopes trial. A few periods later a kid came by and asked if I was an atheist. These students are riled by a discussion of evolution.*

Perception of the appropriateness of dealing with controversial issues was discussed in Chapter 12 of this report. Also in Chapter 12 we reported on CSSE survey scenario Y which examined a teacher's use of repartee in dealing with a potentially controversial situation.

The safe approach was the non-controversial approach, sincerely (we believe) preferred by most teachers and parents. It was to stick to the facts, specifically those facts that the community believes and the textbook supports. To encourage questioning of facts and beliefs, to dwell on relativity and interpretation, was to stimulate controversy. Given community expectations as they are, preferences of a majority of teachers, and the responsibility of teachers to honor these expectations, it seems unlikely that the social studies curriculum will become more oriented toward being a social science curriculum than it is now.

The Basics

For a number of years George Gallup has polled the citizenry about American education. Often he asked, "What is the most serious problem?" and "What is most right about American schools?" Regularly, the response that the curriculum is "what's right," never appeared high on the list of problems. Until the last year or two. Now, for the first time, substantial numbers of people were saying that the curriculum needs changing.

The direction of change was also clear. In the latest poll over eighty percent of people acquainted with the "back to the basics" movement responded in favor of it.* In our own CSSE survey we proposed the following hypothesis and got these responses:

> The schools have been creating "new" courses and having students work on topics of their own choosing. As a result of these and other circumstances, the schools give too little emphasis to the basic knowledge and skills that every youngster should learn.
>
> | | |
> |---|---|
> | Of 179 teachers | 55% said, "Yes, it's true" |
> | Of 250 senior class students | 30% said, "Yes, it's true" |
> | Of 142 parents of seniors | 64% said, "Yes, it's true" |
>
> The "I don't know" responses ranged from 9% for parents to 18% for teachers.
>
> Percentages are unweighted, based on the division of those responding to the item. Standard errors are given in Chapter 18.

What is Basic? When that many people agree on a value question it is wise to look for ambiguity, and there is ambiguity in what the "basics" are. Most people think of "the 3 r's," reading, writing, and arithmetic, when they speak of the basics. In practice, only the bare-bones technical skills of reading and simple arithmetical operations were getting primary attention in this emphasis on the basics. Interpretive reading, fundamental mathematical concepts, and expository writing were not included in the emphasis.

Many teachers of course had lists of knowledge areas that they considered basic, and they often conceptually included these when they lended support to a "more basic" curriculum. These areas were central to the structure of subject matter, including such topics as the conservation of energy, economic scarcity of goods and labor, photosynthesis, and the reinforcement of behavior. Many teachers considered the ability to

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*George H. Gallup, "Ninth Annual Gallup Poll of the Public's Attitudes Toward the Public Schools" Phi Delta Kappan 59 (September 1977): 33-48.

study, to learn independently, to solve problems in groups, to use reference sources, etc., basic to a child's education. One of our site visitors in URBANVILLE, physicist Arnold Arons, commented (p 5:26):

> I noted that the teachers we talked with (particularly the elementary and junior high teachers) seemed not at all sensitive to the fact that competent and effective implementation of the better inquiry-oriented science and social science curricula might have the potential of significantly upgrading both the language skills (reading facility and reading comprehension as well as speaking facility) and arithmetical skills of the children. Teachers who have developed some genuine competence in the handling of such materials are, in my experience, far more sensitive to the impact of such curricula on the basic skills of children, and they are less ready to regard science and social science as not having a place in the "back to basics" formula.

Many teachers noted rapid changes in social responsibility for individuals as older structures, e.g., the nuclear family, the church, and the civil authorities, change. They spoke of the "basic" responsibility of each person to exercise societal rights and obligations and the role of the school in assisting.

Joseph Cronin, Illinois Superintendent of Public Instruction, proposed a fourth "r" (as have advocates of a variety of things), this one "Responsibility Education," as described by Alan Lemke earlier in this Chapter. Here too is a strong support for "the basics" but with a special interpretation as to what is basic. The fact that we observed large differences thereas to what basic education is should not cause one to slight the fact that there was at the time an immense belief that the schools could offer a better curriculum, one that does more to assure that youngsters are grounded in common linguistic skills and are knowledgable about traditional subject matters.

TEACHER BACKING

To be sure, many teachers were not much concerned about the flap over "a more basic" curriculum. In discussing "back to the basics," a large number said something like the sixth grade teacher in RIVER ACRES, Texas, (p 1:18) who answered, "Back? We never left!" It was not unusual for teachers to respond that they were doing everything we inquired about--but here at least, clearly she was correct. They were teaching pretty much what teachers across the country had been teaching in math and science in 1950.

In ALTE (p 3:14ff) the "back to basics" movement appeared to our observer to be concentrated in the controversy over IPI mathematics. Several years ago a "perceived need" for individualization of instruction--apparently rather than objection to the more highly conceptualized mathematics books being used--persuaded one elementary faculty and later an aggressive assistant superintendent to promote IPI mathematics. According to observer Lou Smith, it was more a concern for "organizational structures for coping with curriculum responsibilities" than a concern for performance levels of the youngsters, though some of the latter, of course. The program evolved. At the time of our observations district policy was that one half of the instruction would be

IPI and one half "teacher developed." The issue remains controversial at ALTE. The complexity of the situation, involving teacher autonomy, professionalism, administrative roles, competing advocacies, multiple kinds of evidence of instructional effectiveness, etc., is nicely spelled out in the ALTE case study.

We were surprised by the strength of the response from teachers, both in the CSSE survey and through our contacts in the field. We expected to find teachers seeing the call for "back to the basics" to be a threat to what they considered the proper course of study and a criticism of their work. We expected them to protest that a greater emphasis on the basics would be departure from the concepts and complex relationships so necessary for understandings in science, mathematics, and the social sciences. Some did, as shown in the survey results below.

In one of our scenarios we created a science teacher named Foster who claimed that "more emphasis on uniformity is going to erode support for the college-prep program." Although it is generally assumed that the objectives of a traditional curriculum can be preserved and pursued when a school adopts an objectives based program, we asked our respondents to test the idea against their experience. We presented the following question to three groups and got responses as indicated:

> Foster seems also to be suggesting that the science curriculum is competing with the objectives-based curriculum--rather than being supported by it. Do you feel that funding for the one, if spent properly, would support the other? Or do you feel that districts just have to make hard choices between traditional and objectives-based studies?
>
> "The methods and goals of traditional and objectives-based curricula are relatively independent; therefore, they compete for funds,"
>
> was the answer given by: 9% of 126 elementary science supervisors responding
> 13% of 47 high school principals responding
> 43% of 43 parents of seniors responding
>
> "The methods and goals of traditional and objectives-based curricula are highly related; therefore, they do not really compete for funds,"
>
> was the answer given by: 86% of the elementary science supervisors
> 77% of the high school principals
> 53% of the parents of seniors
>
> The remainder checked "other" and some added their alternative conclusions. The standard errors for these unweighted percents are not available. Related information is presented in Chapters 14 and 18.

As shown above, some teachers were concerned about how an objectives-based curriculum, (which to many people is a "back to basics" curriculum) will affect the traditional program. In our sites we found some in doubt, but large numbers of teachers were more vehement than parents, urging a greater stress upon the basic skills. Some seemed to

imply that they had not been allowed to teach as they had wanted to, that they sought the freedom or a mandate to teach something other than what they nad been teaching these last several years.

It was our observation that the teachers in all our sites had a great freedom to teach largely what they please. This was a freedom within limits--and if they approached those limits the parents or board objected. They were obligated to organize their work in most of these schools around a certain syllabus or set of topics. But in the high majority of schools teachers were not obligated to use the same tests or quizzes other teachers use. There was extensive use of packaged programs such as IPI math and Project PLAN so teachers had less leeway then. There was little direct supervision to see that they gave a certain emphasis to certain skills or topics. Rather it was generally announced and implied that teachers should teach in ways that work best for them, and not to expect to be identical to other teachers in the school. We often heard claims that this was just a matter of style, that they were all pursuing the same goals--but was obvious to any observer that in these separate styles was a great difference in interm diate goals, in the development of personalized experience and cognitive associations, and in dwelling upon the rudiments of the language arts. Thus, we found that the teachers taught in largely different styles and, at least in the short run, covered quite different ground; that they felt strongly about this opportunity and privilege to direct their own work; that most administrators and parents agreed that they should have this responsibility--yet we heard many from all groups urging a "return to the basics" and a need for more uniformity of curricula.

It seems reasonable to interpret some of the teachers recent emphasis on "the basics" as a reaction to the difficult teaching demanded by the curriculum reform efforts of the 1960's and a reaction to the poor performance record of many students. As described in later sections of this chapter, the new curricula covered topics the teachers were not prepared to teach, and some of the curricula required teaching roles (inquiry, neutral observer, devil's advocate, etc.) that were unusual, difficult, and even psychically hazardous for them. There has been public indignation about newspaper stories of students who hold a high school diploma but cannct read at grade school level. Most teachers saw these as isolated cases of students unwilling to learn, and teachers unwilling to make them; but many saw too an inflation of expectations as to what the schools should be doing diverting attention from teaching the basics.* In the RIVER ACRES, Texas case study, (p 1:196) observer Terry Denny pointed to still more and complex reasons that contribute to the vocal support teachers in our sites are giving to the "back to basics" outcry.

Raising Standards. In interviews with teachers our observers heard frequent reference to a need for raising standards. The reference here, of course, was not to a higher quality curriculum but higher quality performances of students, the contention being that teachers should insist upon better work from students. It was most frequently raised by teachers who preferred a more traditional curriculum, many of whom were also calling for a return to the basics.

It was interesting to us to note that the cry for standards was almost never expressed by those who advocate a more modernized and conceptually oriented curriculum.

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*See Carl Bereiter. Must We Educate? (Englewood-Cliffs, N.J.: Prentice-Hall, 1973).

Those people too were interested in raising standards, but presumed that the traditional course of study was part of what needs improvement. Also, those who favored matching talent and interest of the youngster within an array of electives were seldom the ones to speak of raising standards. Nor were they who advocated equal opportunity for poor and minority youth. It was primarily those who want a common, traditional curriculum for all students--one where it will be clear as to who are the "A" students, who are the "B" students, and so on.

It was apparent that teachers were sincere in their efforts to raise standards. It was also apparent that there were important side effects. In the short run, it may improve the teacher's image to be an advocate of higher standards for students. But in so doing, teachers may put themselves and their students to further disadvantage by raising false expectations for achievement. At VORTEX in Pennsylvania we heard how an emphasis on higher standards hurt in two ways (p 10 1):

> *Mathematics is dominating the junior high science curriculum (now) so fewer students choose it at the upper levels because 'they're turned off.' The 8th grade science course is so demanding! It has replaced general science as a stepping stone to high school. The latter was much better because it was a good introduction to biology, physics, and chemistry.*

Just how complex the picture was is more apparent in the case study.

Reading Skills. We found an almost universal belief that good reading skills were essential to other learnings. It is obvious to all that everybody learns many things without depending on reading, but still it was believed that important scholastic learnings are dependent on reading. Thus, science teachers and sociology teachers were just as insistent as language arts teachers on large allocations of school time for reading. Here are the words of a junior high school building principal, a former science teacher experienced with public schools and private schools.

> *Very little science is taught in the elementary grades--and understandably so. Mathematics and reading, especially reading comprehension, are the best preparation for later work in science.*

A fifth grade teacher at our BRT site in Illinois said:

> *Reading comprehension is the bridge to scientific literacy.*

In Alabama we talked with a group of black teachers who had been involved in various "remedial" programs, particularly at the freshman level. One, a former high school chemistry teacher and participant in an NSF summer institute, said:

> *Reading for understanding is the biggest need these kids have. Most math teachers concentrate too much on teaching rules, principles, and the like. But the kids can't read that well. They may perform the task, guided by oral directions, but fail to grasp the meaning of what they are doing.*

A director of a Title III project, a counselor by training, agreed:

> *Students are quick to admit their deficiencies in mathematics. But they fail to see their deficiencies in reading.*

A director of a remedial lab, long experienced with Title I, added:

> *To understand the question is to understand the answer. Students not only experience difficulty with key words, but also in detecting the influence of context on these words. In biology for example, the subtleties of distinguishing between a "correct" response and that "desired" by the teacher is a major obstacle. In math, the instructors do not grasp the need of students to understand terminology.*
>
> *There is much confusion between reading and English. Reading is a process. It should not be taught as a "subject." Under certain conditions students may do well in English but not be "good readers" the way we expect our scholars to be.*
>
> *Treating reading as a subject has caused instructors to neglect responsibility for teaching students to read subject matter particularly appropriate to special areas of knowledge. Every teacher must be a teacher of reading in his domain of scholarship!*

A Pennsylvania science teacher we watched was showing a film strip on "freezing and boiling." He interrupted to point out one caption, saying, "Now that's a terrible sentence! There has to be a better way of expressing that point." How he added his testimony to the need for every teacher teaching reading and writing is told in the VORTEX case study (p 10:9).

Across our eleven sites we found widespread support for teaching reading, the "most basic of the basics," as one teacher called it. Science teachers handled this responsibility in many different ways, of course. There were pressures to cover their own syllabus or list of objectives, so no teacher felt entirely comfortable departing from the lesson to teach reading. But the conviction that learning is dependent on reading skill was strong, and most teachers we talked to wanted to help youngsters to increase their reading comprehension.

A Vignette on Basics. After visiting several of our sites CSSE co-director Jack Easley wrote the following vignettes to illustrate the "crunch" that nourishes the feelings that we have to re-emphasize the basics,--but hopefully in a way to make a difference.

> As Mr. Snow, an experienced life science teacher at Maas Junior High School, put it, "These kids can't read, and their arithmetic is really weak." He was not particularly relieved by the fact that the language and mathematical achievement scores of entering 7th graders are quite uniformly two grade levels above national norms.
>
> What bothers him is that they can't read a textbook and understand it. They can't follow directions for experiments. And working with numbers really bothers them.

In this classroom I observed students doing experiments which, he explained to me, enabled them to earn 10 to 15 points each if satisfactorily written up. Ninety points resulted in an A on the lab work for the unit. His grade book was open (and so marked) and students came up to see how many points they had earned.

A group of three girls (one of them the only black in the class) had written "CONVECTION CURRENTS" in the ditto'ed blank for the title of their experiment. Their books were open to a page which showed a small picture of the apparatus with arrows showing the water moving in the beaker in a circle. When I asked them what "convection currents" meant, one of them skimmed the paragraph above the picture and found the sentence which said that they "carried heat from one place to another." When I asked if that was a definition, another looked in the glossary of the book and came up with a more elaborate and technical definition.

Mr. Snow approached them and commented that the bunsen burner was supposed to be under one edge of the beaker. "Which edge is it under?" He asked. Viewing it from different angles, the girls couldn't agree, but they didn't move it either--perhaps not wanting to admit it was centered.

Mr. Snow said, "If you were just starting, I'd have you put the beaker much lower, just over the flame instead of way up there where you have it." "Does it have to boil?" they asked. "Oh, no," he said, "you can put the ink in any time." (There were lots of bubbles all over the sides of the beaker.) The girls finally agreed it was time to drop in the ink. The water instantly became dark blue.

"What's supposed to happen?" A girl at the next station said, "The ink is supposed to go up and down." All wrote in the Results space that the ink went up and down. When I mention the bubbles, as it was now boiling, one wrote that there were bubbles. Two admitted they didn't see the ink move, but after the write-up and disassembly of the apparatus I asked if they wanted to try it again. They all said they did not.

They handed in their reports. Other students seemed to be doing little better. It was easy to agree with Mr. Snow that they did not understand how to do experiments and could not read or follow directions. Or drawings either.

. . .

Fred leads the Wildwood project for the sixth grade at Hilltop school. He shares the classroom teaching with another teacher. As he talked about planning for the week-long outing coming up, he mentioned that many students could get the right answer to questions about how many of this or that supply they would need, but couldn't do it systematically by arithmetic. "Those who were best in classroom arithmetic," he said, "often couldn't figure out practical quantities for a real project.

Later, I visited his arithmetic class and found students working on logs of different problems (self-paced). Many had their hands up and I accepted his invitation to try to help. The students did not seem to be happy, but they were not really "goofing off" very much.

I wandered from one raised hand to another, sometimes being refused ("I have to ask the teacher this one."). One boy invited me to help him, then a girl at the same table. Finally I was busy, busy, trying to grasp the word problems, work them myself mentally, and understand the work of the students.

A girl solved an astronomical problem after discussing it with me. I couldn't follow how she did it. For a long time she was stuck, then suddenly she was finished and on to the next problem. I wanted her to show me her work, but she just had a scribbly page of scratch paper, with multiplications and divisions written one on top of another.

Mr. Murphy, the principal, in response to my summary of the outdoor project planning difficulties, described a mini-class he was running. It involved setting up and manufacturing hanging planters made of string and wood. He said he was going to let the kids do everything, including buying the supplies. He said he hoped they would have to borrow money and pay interest on it.

He said that when they came across a practical arithmetic problem he just let them struggle with it. It might take them two days. They eventually got it figured out to their satisfaction and his. I expressed interest in the magnitude of the problem. He admitted he couldn't figure how he could reorganize the whole curriculum so the kids would be able to make the connection between school arithmetic, where the problems were already formulated, and useful arithmetic where you had to figure out what the problem was, what to do, and how to write it down.

He admitted that, the way teachers did it in the classroom, (the way I did it in Fred's room), the kids would forget what they had been shown in a week. Such teaching had no utility, he felt.

But he had contemptuous words for the junior and senior high teachers who were demanding more math and reading skills than they find already in their students. He grabbed his test score printouts to prove to me that these kids were really doing far better than any high school teacher had a right to expect.

. . .

Jake Berlyn, the recently-appointed principal of Cody Elementary School, confirmed what I had observed, that the cadet-teacher in upper grade mathematics was a very competent person and the two aides were quite experienced.

For the second time in two weeks I had the opportunity to help out as a teacher's aide, this time in place of a paid aide who was absent. It was in the "best" fifth grade class. We three adults sat at tables scattered throughout the math class area. The sounds of other classes working in full view but a dozen yards away in several directions did not disturb us.

Soon there were three students cued up behind my chair awaiting my help. I was working with Al, an oriental boy who did beautiful long division, with decimals, but couldn't figure out in word problems what to divide into what.

One group of problems involved a table of the amounts of thiamin per 10 grams of different foods. The question was: How much thiamin was there in one gram of each? Once we had figured out one case, he hastily wrote out the answer for the others.

The next problem concerned a boy who went to the store to buy hamburger. How much could he buy with the money he had, given the price per pound? Al was lost. I posed a simpler problem. The boy had $2.00 and the price per pound was $4.00. Al came back right away with "8 ounces." After he converted it to pounds, which he could obtain that answer by division (avoiding the familiar question, "How did you get that answer?" He wrote: $2/\overline{4}\,.5$ I asked him to check it to see if it was right. It wasn't. So I asked him to try again. He couldn't think of anything else to do. When I suggested he interchange the 2 and the 4, he was really surprised to discover that it worked.

Jake Berlyn agreed with me that there was insufficient time in the math classes for three experienced adults to help 20 children adequately so they would understand the math they were expected to do.

The student teacher pointed out to me the individual Stanford Achievement scores for each pupil. They were almost all two grade levels above present grade. We looked over the individual test items, even the "application items", and decided that many of the "distractors" were so far-out that kids could get a good score based on intuitive knowledge, without being able to understand how to work the problem.

Berlyn agreed that if math were taught with one teacher per pupil there might be reason to hope. We did not bother to go over the administrative and budgetary reasons that precluded teaching one-on-one. It was, he agreed, an indication of the magnitude of the problem.

Reading was a similarly acute problem, even though no one in the district was reading below grade level on national norms. Those kids ran into a big reading problem when they went to the junior high, a school where, Mr. Snow admitted, the 7th grade life science text had a 9th grade reading level.

Nelson Capretz, principal at Maas Junior High School,. . . was visibly upset at the above report. He reminded me that there were no illiterates in his school.

This vignette, perplexing and distressing, originated in a cluster of "advantaged" schools, ones with hard-working teachers; bright, dedicated administrators; reasonably cooperative students; and reasonably generous taxpayers. The problems of reading laboratory-directions and working word-problems are easily recognized by those who attended American schools before World War II and after. The children were not learning what we thought was a bare minimum, and we do not have any prospective changes--with or without a reasonable price tag--that would have a reasonable chance of success.

It would be comforting to be able to point to empirical justification for the new American reliance on the "basics." If we could only point to circumstances where a heavy emphasis on reading and arithmetic had in fact overcome the malaise of poor achievement, had stiffened the backbone of the students, and made the quest for literacy a thing of the past. We cannot point even to instances where that has started to happen.

MOLECULARIZATION AND SEQUENCING

Over the past twenty-five years school curriculum has been subjected to review and reconstruction. Particularly noteworthy has been the work of such researchers as B. F. Skinner and Robert Gagné. Theirs has been a rebuilding along task analytic, characterized by such admonishments as: "define the behaviors to be taught; identify the component parts; and teach the components in a sequence which has been empirically validated."

Such an analytic approach has historical roots in the Socratic dialogue and the Armbruster sch . It is the pedagogical rationale for the IPI instructional system and for Engleman-Becker DISTAR materials. The task analytic approach is now becoming known among technologists as the "direct instruction" approach. It is highly visible today because it is an obviously good way to combine educational technology and an emphasis on the basics.

Analysis of Objectives. When we discussed the needs of the science curriculum with a science curriculum coordinator at the URBANVILLE site, she told us that for a long time they had resisted specifying the objectives of their program, fearing that it might dilute the subject matter or diminish the effectiveness of creative teachers--but they found for several years running that the Board of Education would only support those curricula that were so specified. They borrowed the massive catalogue of objectives produced by the Portland, Oregon school system and were hoping to build back the place of science in the curriculum. She was not at all unhappy with the new way of presenting their goals--just that it had taken so long to get it going.

We found that the task analytic approach supported media-oriented instructional programs, particularly those that were laboratory based. The Math Lab at VORTEX (p 10:8) was an excellent example. Those programs and spaces seemed to work exceptionally well, even when they became isolated enclaves, as long as enthusiastic teachers ran them. When those teachers leave, the programs are not easily picked up by other teachers--reminding Gordon Hoke, our VORTEX observer, of the fate of the Language Labs spawned by NDEA legislation (p 10:13).

The analysis aspect is always stronger than the synthesis, it seems. Thus the components were often taught rigorously and strenuously, as they were at BRT and FALL RIVER. The process of combining the components into complex responses for problem solving in naturalistic situations was de-emphasized, or even omitted. To most observers the curriculum had a molecular rather than wholistic appearance--which most perhaps considered an asset. The students impressed them by doing well on the criterion-referenced tests developed for the particular instructional sequence. Gains on more general tasks were seldom documented, and usually controversially interpreted. (See, for example, the difference in two interpretations of Follow-Through planned variation studies.*)

Sequencing. It is argued by the advocates of the basics and by the task analysts that one or a few sequences of instructional materials will be markedly superior in long term results. This will be discussed at greater length in Chapter 16. There were few teachers who argued for sequences of experiences extending up and down the grades, requiring simple exposures to complex phenomena in earlier years and complex involvement later. But most teachers agreed with a junior high principal in VORTEX (p 10:10):

> *Teachers are very uncomfortable with science. You really can't blame them. Personally I think instruction in science should be left to the upper grades. About all you can ask for is solid preparation in reading, especially comprehension, and mathematics when they reach you in junior high.*

*Abt Associates, Inc., Education as Experimentation: A Planned Variation Model, Volumes IV A-D, Cambridge, Mass., April 15, 1977; and Ernest R. House, Gene V. Glass, Leslie D. McLean and Decker F. Walker, "No Simple Answer: Critique of the 'Follow Through' Evaluation," Harvard Educational Review, in press.

SCENARIO U

The influence of the "back to basics" movement on the K-12 curriculum was apparent in all our eleven sites. We prepared the following scenario to explore the issues discussed in this chapter in communities of our national sample. We presented the following scenario to high school social studies curriculum supervisors, high school mathematics teachers, and elementary school principals.

Scenario U

Please consider this dialogue between two teachers, Maria and Jim, at a curriculum workshop:

Maria: It's a lot of work, but I'm glad we are specifying just what our curriculum is. The more specific we are the better. It should help us concentrate on teaching the basic skills.

Jim: But are we really describing the old curriculum or creating a new one? With the new mastery requirements will we have time to do enrichment projects and science explorations?

Maria: We've spent too much class time on field trips and science fairs. We must set our priorities and spend the time where it should be spent: on reading, writing and arithmetic. Knowing what we need to teach will help us use tests to make sure we did it. We will eliminate the irrelevant topics and unrealistic goals.

Jim: I'm not that optimistic. Three summers ago I revised a course using behavioral objectives. But in the all I felt tied down to them. They seemed too narrow, too simplistic. So I stopped bothering with them.

Maria: Well, we are not writing behavior objectives. We are dividing the curriculum into mini-units and constructing mini-tests. Next year we will be able to show exactly what we have covered and what each student has learned. There is nothing narrow about this; if we want students to know complex relationships we just say so.

Jim: I wish you luck. Dan Thorpe told me that in the competency-based math at his school, the tests do not accurately represent what the students know. No matter what competencies they would specify, they always ended up teaching and testing for the simpler things, leaving out lots of complex things. It bothers me.

Maria: I'm not worried if the tests do not reflect the complexity of knowledge. Our job is to make sure that every boy and girl has the minimum competencies to continue to the next grade or graduate. They need to know the basics in order to get along in today's world.

Scenario U continued

We had the following responses to this scenario:

Group	Original sample size	Number of responses
Math teachers, grades 10-12	150	94
Social studies supervisors, grades 7-12	201	153
Principles, grades K-6	94	59

All percentages given were weighted according to the RTI sampling plan. See Chapter 18.

1. Are your feelings more like those of Maria or Jim?

	Maria	Jim	Neither	A little of both	Total Responding
Math Teachers	48%	10%	8%	34%	93 of 150
Social Studies Supervisors	37%	4%	14%	45%	151 of 201
Elementary Principals	30%	10%	9%	46%	58 of 94

2. Is the issue "Back to the Basics" important in your community?

92 of 150 Math Teachers	150 of 201 Social Studies Supervisors	57 of 94 Elementary Principals	
63%	63%	72%	___Yes, an important issue
28%	15%	3%	___No, but it should be
0%	1%	0%	___It was, but is no longer
9%	21%	23%	___No, not an important issue

3. What is your own feeling about increasing emphasis on teaching basic skills and knowledge?

We found our respondents split between increasing emphasis on the "basics" and stressing the need for balance between the basics and other skills and curriculum. Some of our respondents made comments as follows:

A math teacher in Worthington, Ohio: Necessary but not sufficient.

An elementary principal in Fairdale, Kentucky: Excellent, glad to see the pendulum swing back!

Scenario U continued

An elementary principal in Jefferson Heights, Maryland: I am concerned that the emphasis is becoming over-emphasis.

A math teacher in Broadmoor, Colorado: Basic skills must be mastered but not for the fact itself. . . rather to be able to project and use this knowledge to new situations: i.e., the idea of total education is to be able to GENERALIZE on the basis of knowledge.

A high school social studies supervisor in Brockton, Massachusetts: I'm all for it but not to the exclusion of everything else.

A high school social studies supervisor in Liberal, Kansas: Teaching only the minimum competencies will develop only a minimally competent student. The nation has enough of those now. Minimum skills are, however, very important.

4. Maria is pleased to be dividing the course content into small units and to be specifying competencies in each. Which of the following results do you think will be accomplished more effectively by this approach? (Check as many as you wish.)

94 of 150 Math Teachers	153 of 201 Social Studies Supervisors	59 of 94 Elementary Principals	
80%	67%	86%	___setting of priorities and allocating time for instruction
57%	45%	15%	___removing unimportant matters from the curriculum
40%	41%	53%	___raising or maintaining high standards of achievement
5%	29%	10%	___giving teachers more flexibility and freedom
23%	41%	31%	___making courses more relevant to the pupil's experience
7%	12%	1%	___other (Please specify):

5. Some people urge a big push to teach reading skills and math facts alone at first. Other people say you need to teach lots of basic information while teaching the skills. Others say "teach analysis and even interpretation at the same time." What do you say?

93 of 150 Math Teachers	146 of 201 Social Studies Supervisors	58 of 94 Elementary Principals	
57%	26%	36%	___I say "Teach the basic reading and math at first, the other things later."
17%	14%	15%	___I say "Teach basic skills and lots of content first, leave analysis for later."
20%	38%	45%	___I say "Teach all those together, all the time, in every grade.
6%	22%	5%	___Other (Please specify):

6. Some people think that scientific knowledge is "basic." Why are reading, writing, and arithmetic usually mentioned as "the basics" in elementary education and not science?

91 of 150 Math Teachers	147 of 201 Social Studies Supervisors	58 of 94 Elementary Principals	
0%	0%	1%	___Only a few people really need scientific knowledge
71%	51%	60%	___Science is basic but you have to teach the 3 R's first
1%	7%	0%	___Science can better be learned outside the elementary school
4%	16%	18%	___People who stress the 3 R's do not understand today's needs for education
24%	26%	22%	___Other (Please specify):

Out-Of-School Learning

There are at least as many opportunities for youngsters to learn science outside the school as in. This CSSE project did not directly consider the present status of out-of-school learning opportunities, but our field observers could not help but encounter them as they talked to teachers and students. We found it useful to distinguish between those opportunities chiefly arranged by people within the schools and those arranged by others. This of course is an important practical distinction for the National Science Foundation because extending science education offerings not arranged by the school calls for commerce with a new array of institutions, e.g., museums, television studios, public park programs and youth organizations such as the Future Farmers of America and Young Women's Christian Association.

Out-of-school programs arranged chiefly by school people included outdoor education, trips to museums, assignments to see movies and television programs use of public libraries, and field trips. We were surprised to find relatively small use of out-of-school activities that required taking the class as a whole outside the school. In Columbus, Ohio, even during a period of special need, when honorifics were extended to field trips, observers Jim Sanders and Dan Stufflebeam found their use to be small. Primarily because they found it extremely difficult to get volunteer adult chaperones, teachers in ARCHIPOLIS had their trips to museums to about once per year.*

But we found some outstanding examples of school science outings, there at ARCHIPOLIS and elsewhere. An excellent use of out-of-school opportunities to learn science had occurred in the ALTE schools. From kindergarten to 12th grade the children participated in a year-round outdoor education program: arboretum, camp, ornithology trips, climbing, exploring. At the Nature Center observer Lou Smith saw (p 3:52):

> the teacher and a half dozen of his kids (bring in) a whole set of equipment and materials and set up shop in one of the outbuildings. . .empty aquariums, work tools, a library. It was an incredible picture. . . And everyone seemed to be working in, working on, and working about with the materials. . . .

The success of the program was partially attributable to support in the district office, at each school, and in the homes of many parents. Most of those homes, it is remembered, are fully able to afford libraries, camps, and trips of their own.

But those examples were the exception. As we made our visits to the eleven sites we heard perhaps the full array of reasons why it was logistically impossible and

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*We noted that insurance costs and liability, transportation costs, availability and qualification of chaperones, greater demand on school buses, etc. have reduced the use of field trips. These restrictive forces are at work of course, in many ways in our society, not just in education. (The NSF could consider unusual ways of sustaining field opportunities, such as by underwriting insurance.)

pedagogically inefficient to use out-of-school resources. We asked about this condition in our national survey, setting up a common claim to measure the support for it (passing up the opportunity to establish alternative claims or the reasons for or against the claim). The claim in this instance was:

> Teachers seldom use TV, museums, and community resources to supplement teaching.

Percent of people agreeing with the claim:

	Large city >100,000	Large Suburban	Non-Metro <100,000	TOTAL	Number Responding
___Teachers	36%	39%	24%	26%	177
___Curric Supr's	47%	50%	31%	34%	238
___Administrators	29%	1%	32%	19%	77
___Students †	58%	74%	69%	67%	248
___Parents †	50%	44%	49%	44%	138

(Readers will note that the claim is worded negatively. Apparent discrepancies may be due to the limited numbers of respondents in each category--e.g., "Administrators.")

	West	Midwest	South	Northeast
___Teachers	25%	42%	12%	19%
___Curric Supr's	19%	33%	47%	30%
___Administrators	1%	12%	15%	87%
___Students †	55%	66%	66%	77%
___Parents †	33%	45%	48%	43%

Percents are based on the group responding to the item.
Standard errors are not available for these weighted percents.

†Unweighted percents are used for students and parents.

One Colorado elementary school principal said:

> *I think at times we have had a little smattering of everything and not much of anything. And yet, I do not think that our kids are coming out of it illiterate. I think what they're learning is being learned outside the school.*

MUSEUMS

One may recall the words of Loren Eiseley,* the late paleontologist:

> *The boy under the street light may become fascinated by night-flying moths or the delinquent whisperings of companions. Or he may lie awake in the moonlight of his room, quaking with the insecurity of a divided household and the terrors of approaching adulthood. He may quietly continue some lost part of childhood by playing gentle and abstract games with toys he would not dare to introduce among his raucous companions of the street. He wanders forlornly through a museum and is impressed by a kindly scientist engrossed in studying some huge bones. . . .*
>
> *There are subjects in which I have remained dwarfed all of my adult life because of the ill-considered blow of someone nursing pent-up agressions, or because of words more violent in their end effects than blows. There are other subjects for which I have more than ordinary affection because they are associated in my mind with kindly and understanding men or women--sculptors who left even upon such impliant clay as mine the delicate chiseling of refined genius, who gave unwittingly something of their final character to most unpromising material. Sculptors reaching blindly forward into time, they struck out their creation, scarce living to view the result.*

The education community sometimes loses sight of the sources of enlightenment and compulsion in our lives. The commitment of a youngster to become a scientist or a responsible citizen is less a matter of skill or reason, more a matter of conviction, aided by kindness and understanding shown by teachers, shown in chance encounters, such as young Loren's with a kindly scientist in Morrill Hall on the University of Nebraska campus.

Well, a museum is one of the last places to look for a kindly and understanding display of stuffed peacocks--at least so many people feel. The Education Curator at the museum is almost the least significant of functionaries. If the holdings won't be damaged the public is welcome and public school groups will be tolerated. There is seldom energy and patience to put up with a noisy generation of young visitors. A staff member rarely breaks out from protectiveness and indignation and waits upon the unending stream of children. Such a teacher-curator, however, there was in the Science Museum in Boston. Rob Walker reported (p 11:30):

> A large bearded man wearing glasses is sitting up on a dais in a corner of the museum. Next to him a column emits lightning sparks. As he talks the fluorescent light tube he is holding over his shoulder glows, even though it is not connected to anything. . . . goes on to explain the apparatus doesn't

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*Loren Eiseley, "The Mind as Nature" (New York: Harper & Row, 1962) reprinted in The Night Country, (New York: Chas. Scribner's Sons, 1971), p 201.

> have much practical use. . . a good bit of the time he tells Tesla. . . . Again there is a feeling here someone is talking about something he really cares about. . .

But again, the contribution of museums to science education is seldom person to person. More common are the displays and the models (e.g., water works, great grandmother's things), even ones you can play with, such as the teletype terminals at Berkeley's Lawrence Hall of Science. At a museum computer terminal in Boston (p 11:30):

> a boy sits filling up the display with digits and then clearing them. After repeated attempts he tries the other keys, add and subtract for example, and seems puzzled when nothing happens. The other functions (like squares) are more rewarding. When you press those, the numbers move.

(Site visitor Hassler Whitney noted, "none was in use when I was there.")

How is the child's mind stretched in new ways toward the systems of science? How are aspirations affected by the visit? Museum program evaluations cannot tell us yet, perhaps never will. These sharings of inexplicable experience (but a sample here of many there in the GREATER BOSTON case study) were summed up in the words of a young staff member named Daniel (p 11:31):

> *I think we in America expect too much from our schools. The way I see it, there are two distinct systems involved in education. One is the learning of ways of conceptualising and categorising: what Bruner calls, "learning how to learn." The other is the development of personal metaphors for understanding the world.*
>
> *I don't think schools, or perhaps any other institution, can cope with the demands of both systems. Schools may be very good places for learning symbol-systems, for learning how to communicate, and for learning how to survive in our kind of society. They just seem to be rather poor places in which to learn science. The two different systems just are not compatible with each other. Learning in the sense of realizing personal metaphors for understanding the world is, I think, best accomplished in more intimate social contexts than you find in most schools.*

The science museum can be such a context.

EDUCATIONAL TELEVISION

Reflecting upon our encounters in the few places in our eleven districts where there was a strong effort to use television for science education, we were persuaded that programming done by the schools or for the schools has little promise, but school use of other educational or commercial television and individual student use of television have considerable promise.

The Schools Without Schools emergency program in Columbus, Ohio, gave us a brief look at school-based television under poor logistical but highly favorable socio-political conditions (p 8:7):

> While. . . TV was the most visible part of the program and the one that received the most national acclaim, it was also one of the weakest instructional parts of the Schools Without Schools program. This was not because the programming and presentations were poor, but because there was little motivation to use them or opportunity to relate them to the programming and teaching being done by individual teachers. There was little advance involvement of regular teachers in curricular decisions; and advance information about what would be on the media--which was needed by the teachers in order to plan for and use this service--was missing.

The inability in Columbus to organize an elaborate use of television instantaneously should not be much of an indicator of the potential for school-organized television programming. However, the almost complete lack of enthusiasm for this medium and the organizational obstacles it faced (especially at the secondary level) should indicate some of the difficulty that programming would face.

Successful coordination of school use of public broadcasting services was demonstrated in our Pennsylvania site. Observer Gordon Hoke wrote (p 10:14):

> VORTEX schools are tied to a PBS station, . . . school buildings--and much of the city--are also wired for cable-tv. Students engage in production and performance activities beginning with the primary grades, frequently preparing video-tapes for local use. ETV is part of the Audio-Visual department, and its director, who is an outspoken advocate of the medium, views instructional television as having a major influence on science education in the lower grades. . .

The use of students in programming is an important feature--to be found in other systems such as St. Paul, Minnesota. The purposes are clearly different from those where students are seen as audience only. Except for the advantage of timeliness with live broadcasting, most audio-visual educational presentations can be handled better in the classroom via motion picture projection than by television.

Very few teachers or students mentioned the use of commercial or educational television for homework assignments. Just once we observed a teacher, this one in a Life Science class in ARCHIPOLIS, doing so. On the board she wrote (p 9:9):

> Homework: Watch, 7:30 tonight, "Wild Kingdom," Channel 10
> 1. Name the population
> 2. Name the habitat
> 3. Describe the niche

It was apparent that students there and elsewhere were familiar with Jacques Cousteau, Mr. Rogers and the cookie monster--and that teachers sometimes encouraged children to watch such shows, but little more formal use was found. Teachers were not passing credit to Sesame Street for getting children more ready for arithmetic instruction

than they would have been otherwise. But these comments were perhaps giving too much credit to planned and coordinated instruction. One teacher said in a response to a CSSE survey question:

> *I believe that television has been education's worst enemy by making students passive learners. Since it is highly unlikely most families will dispense with their TV sets I would urge that the NSF and other education offices pressure the industry to present more scientific and historical features during prime time on commercial stations. PBS broadcasts are wonderful but many students do not watch them and in many homes the reception is not as good as the three major networks.*

As with Loren Eiseley, much of the initiative to learning occurs without planning or purpose. The programming of the commercial networks is well known to the youngsters--it is almost certain that they are stimulated in both good and bad ways. Recently a Yankelovich survey showed three out of four parents agreeing that their children had learned good things from television.*

According to Newton and Nell Minow** "the last group to understand how to use television has been professional educators." They concluded a review of children's television with:

> *As new techniques of production evolve, teachers must learn how to use them. For the most part, public television has advanced in America without the support of intellectuals and academics, who were too busy looking down their noses at television as an inferior medium for the masses. If there were a limited number of printing presses in this country, intellectuals and academics would have vociferously insisted that at least one or two of them be set aside for noncommercial use for the advancement of knowledge and culture. But because the medium involves a technology other than familiar print, public television has had to win public support without the aid or support of the intellectual community.*

One of our site visitors from England, Frances Stevens, commented on her first impression of the color and flair and topicality of American textbooks. The television networks are even more colorful, attention gathering, and (for all their narrowness and over-simplification) broader and more complex in topicality than the American textbook. There are further potentials for science education there.

NONSCHOOL EDUCATIONAL ORGANIZATIONS

Young people and older people alike join organizations for combinations of social pleasure, competition and educational advancement. Among the best known are the YMCA and YWCA, the Boy Scouts and Campfire Girls, 4-H, and Boys Clubs. As social changes

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*General Mills American Family Report, "Raising Children in a Changing Society," Intellect 106 (November 1977): 177-179.

**Newton N. Minow and Nell Minow, "What Are We Learning from Television?" Change 8 (October 1976): 48-49.

have occurred in our society, these organizations have undergone change too, and some have reorganized. The process is no easier for them than it is for the schools. They look for new members, new appeal, and they yearn for the stability of years past. The following excerpt from an evaluation report* of the Shemamo (Illinois) Girl Scout Council is illustrative:

> *Troops are organized around schools, yet schools are the least stable of community organizations (related to busing, family mobility, etc.).*

Many of their educational pursuits have a science orientation: wilderness ecology; ethnic heritage; physiological development and fitness; livestock breeding; etc. A drawback they share with school adult education and university extension services is that the instructors are often less able than the leading students. These students lack an instructional support system in their specializations.

We have noted individual young people, sometimes working with a parent or craftsman, pursuing their study of such matters as the verticalization of pork production and merchandising, repair of high fidelity audio systems, using of polling techniques for newspapers and advocacy groups. To actually give them instruction in relevant sciences might be very costly but to facilitate their personal contacts and opportunities for self-study appears to be a new possibility for science educators. But even to provide them (perhaps through vocational education instructors) with better information on available institutes and informal networks of scientists and technicians would be of value.

Opportunity for supporting** science learning for groups may be clarified somewhat by reporting on one of the popular youth organizations:

> Four-H is praised for out-of-school opportunities for rural youth. Although in recent years 4-H has been criticized for failing to reach minority youth, particularly in the cities, a charge the organization is trying to counter with a variety of new activities, decades of favorable publicity and federal funding have made 4-H a strong organization.

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*Personal communication to CIRCE from the Director, Shemamo Girl Scout Council, Decatur, Illinois, received December 5, 1977.

**NSF support for such independent enterprises as 4-H might require a de-emphasis on the questions commonly asked by the Contracts Office or the Office of Management and Budget, "Can young people get this opportunity to learn somewhere else?" The question of redundancy may not be as important as the question of effectiveness, such as "Are young people actually utilizing this opportunity to learn science?" Redundancy remains a concern in that students can get saturated with certain teachings, such as about ecology and energy today, but those problems too may be better handled by reviewing good data on the quality of opportunity provided by the "educators" and utilized by the "learners."

> "Learning by Doing" captions the masthead of 4-H clubs. Adult volunteer leaders work with youth, ages 8-19, in attempts to give the caption operational meaning. Cooperative Extension centers, normally functioning on a countywide basis, lend technical assistance to the "Doing." (The values of experiential learning were hailed in the 74th Yearbook of the National Society for the Study of Education where the author Richard Graham,* warned that many American youth could not complete the adolescent transition without a reform of education combined with new arrangements linking public schools to other institutions).
>
> Four-H is launching a series of endeavors known as "school enrichment" programs which are designed to bring the agency into closer liaison with local schools. The initiative is certain to "test the waters" of institutional coordination and cooperation, a challenge that frustrated such forerunners as Project Follow-Through, NDEA Title III, ESEA, and other offspring of Great Society thinking. Science Education seems ideally suited to accommodate these 4-H ventures whether they are food and nutrition programs directed at inner-city living or more traditional issues of concern to farm youth.

But there are problems. In Chapter 8 we referred to the absence of a profound sense of relationship characterizing many informal learning opportunities and to the difficulties of sharing responsibility for community education.** The lack of quality scholarship in science-based programs available through the auspices of land grant universities, their extension services, and affiliated 4-H clubs was stressed in an analysis prepared by Andre and Jean Mayer.*** Citing the need for embracing mathematics, astronomy, and physics if agriculture is to honor demands inherent in its future position of eminence, they declared:

> *More than ever, the science of agriculture stands out at the center of a broader system integrating human society and its physical environment.*

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*Richard Graham, "Youth and Experiential Learning," 74th Yearbook of the National Society for the Study of Education, Part I, Robert J. Havighurst and Philip H. Dreyer, eds. (Chicago: University of Chicago Press, 1975), pp. 161-192.

**A recent critique of career education programs warned that "...it might make sense to recognize the limitations of informal alternatives in this post-industrial world." Eleanor F. McGowan and David K. Cohen, "Career Education--Reforming School Through Work," The Public Interest, 46 (Winter 1976): 46.

***"Agriculture, the Island Empire," Daedalus-Science and Its Public: The Changing Relationships 103 (Summer 1974): 83-96.

Unfortunately they feel the Campus-Extension network is too frequently offering simple answers to complex problems.* Submitting that agriculture has become an isolated entity on campuses by developing "its own scientific organizations, its own professional trade and social organizations," and is perceived by farmers as a place where experts treat "practical problems and give immediate answers," the Mayers viewed the end results with serious misgivings: "In the 4-H clubs, the colleges, the experiment stations, and the extension programs, people came in contact with a science that [was] benevolent, useful--and limited." In recent studies of 4-H programs, CSSE personnel encountered another dimension of this critique.

For example, numerous rural households have already incorporated new forms of communications technology into their daily lives. Many families were using two-way radio as a type of telephone linking the house to the fields. Both volunteer leaders and members of their clubs were often engaging in more imaginative uses of media than those allegedly responsible for "teaching" them.

The technological sophistication noted above was crucial to success in certain domains of agricultural production. According to Nathan Rosenberg, Stanford economist:**

> *It is clear--and important--that the kinds of skills generated by agriculture depend very much upon the kind of agriculture one has in mind. . . . The pattern of agricultural activity in the American midwest was of such a nature that it developed a high degree of commercial and technical sophistication on the part of the labor inputs. . . . Midwestern farming has been, to a considerable extent, an example of a complex system of vertical integration on the part of the individual producing unit--the individual farm typically produces the food-cereal products which constitute the basic food input of its livestock population.*
>
> *The midwestern farm is often a fairly elaborate enterprise where the decision-maker must be close to the detailed day to day operations of the farm and which require a familiarity with market phenomena and a wide range of technical skills. Midwestern farming has therefore produced effective managers and people well-versed in mechanical skills who have successfully transferred these skills to other sectors of the economy during the prolonged secular decline of the agricultural sector in the American economy.*

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*The Mayers' criticism is echoed in two recent publications: (1) R. O. Coppedge and Carlton G. Davis, eds., Rural Poverty and the Policy Crisis. (Ames, Iowa: Iowa State University Press, 1977); (2) Wendell Berry, The Unsettling of America: Culture and Agriculture (San Francisco: Sierra Club Books, 1977).

**Nathan Rosenberg, Perspectives on Technology (London: Cambridge University Press, 1976), pp 97-98.

His analysis is reflected in comments submitted sequentially by Archibald Haller and Arlen Gullickson, site visitors to one of the rural CSSE settings:

> School seems meaningless to a surprising number of the students I spoke with. And the outside world, except for their vacation spots, seems unreal and distasteful. What counts is farming, selling farm equipment, and keeping the farm operations running. The students' parents are not especially well educated, and they are doing well financially. The young people do not see much of an advantage to be gained by learning, including science. But "everybody" goes to school, even college, so each one thinks he has to, too. And they do.
>
> It is not at all evident how the cause of science teaching could be promoted in this sort of environment. The science teachers are good and well-funded, but learning apparently seems useless to the students. Perhaps they are learning enough science to be good consumers of it when and if they become farmers, or perhaps in other roles of life. But they certainly do not develop a serious interest in or commitment to science as a vocation.
>
> . . .
>
> I just read Dr. Haller's comment and agree on all but the close of his statement. Science teaching can be improved for agricultural areas, if teachers key on the local resources. I believe that the size of a school does not determine the quality of a program. Also, to me it's not important that the rural children don't grow up to be scientists. It is important that the rural children don't grow up to be scientists. It is important that they know and use science in farming and their daily lives. I think in general curricula are poorly structured for these areas. I suspect well written curricula with titles such as "Science for the Farmer" or "Science in the Rural Community" would do much to benefit science in these areas.

In some parts of the country 4-H perhaps could supply leverage for bringing schools and community agencies together in productive combinations of science education. In places where it has had no history, 4-H could not be expected to be of much aid.

The point here is not to identify an out-of-school organization for a science education alliance or to contend that agriculture is a primary entry for further study of science. The point is that improvement in school-based science education has not resulted from course renovation and teacher support alone. Further efforts outside the school may be more productive than in school. A strategy of using existing programming structures (such as 4-H has, as do public television and public parks programs and others) and finding personnel who are already strongly committed to science education (as museum staffer Daniel was) appear to have untapped potential for improving science education in America.

Instructional Materials

The teacher in most classrooms was in charge of the classroom, not just the presiding officer, but the head of family. And if the teacher was not, no one was, at least no education official was. The classroom belonged to the teacher, not to the building or the district. The teacher was not all-powerful, but without the teacher there was no power, no educational force. Of course there were exceptions, but in most places the teacher assumed the role of arbiter and authority.

CENTRALITY OF THE TEXTBOOK

But arbiter much more than authority when it came to the curriculum. The source of knowledge authority was not so much the teacher--it was the textbook. Teachers were prepared to intercede, to explain, but the direct confrontation with knowledge for most students was with printed information statements. Teachers did it differently from classroom to classroom, but regularly there was deference to the textbook, or lab manual, or encyclopedia, map or chart. Knowing was not so much a matter of experiencing, even vicariously (self-knowledge perhaps was not to be trusted), but of being familiar with certain information or knowing how to produce the answers to questions that would be asked.

> Eight fourth-graders were circled around the teacher for their social studies lesson. Miss Williams asked "Why is New York a world city? At the top of page 142, why is New York City a world city?" (No answer) "Terry?" Terry reads, "New York City is one of the great world cities," and looks questioningly. "No, look on into the paragraph. The headquarters of the United Nations is there and trade with all the countries."

At another site, CSSE visitor Frances Stevens said after observing a history class:

> . . .it was evident that the students were trained to seek answers to questions posed by the teacher, and that their concept of success was to find the right answer.

To be sure, we saw a number of efforts to get students to learn for themselves, to acquire, to discover, to rely on their observation and reasoning powers, but the preponderance of teaching was to import conclusions from a distant authority through the orderly presentation of the lesson materials. It was interesting to note that where teachers were asked how much they emphasized memorization they said that facts were important but that they taught interpretations too--(with emphasis on the factual content of the interpretation rather than on the importance of interpretation fitting with personal experiences and reasoning).

In PINE CITY the physiology class oriented itself to the key questions of the lesson--as stated in their textbooks (p 6:34):

> *"What are three characteristics of the nervous system?"*
> *"What's the difference between a threshhold and a sub-threshhold stimulus?"*
> *"What's the difference between the nervous system of the amoeba and the human?"*

During recitation the answers. . .

> come back in the stylish rhetoric of the textbook. Clearly the essence of the task has been to search the text for the sentence which contains the correct answer.

In BRT a fourth-grade teacher said (p 4:34):

> *In math we have new books in the Macmillan series and we're basically following the order of the book. We've come to multiplication now, but the book assumes a background of multiplicati n that this group doesn't have. So I've arranged for the students to learn at their own rate. I told them they must rote memorize because they can't do complex problems otherwise.*

But not always. In a WESTERN CITY physics class (p 7:24):

> . . . the class was performing a laboratory experiment. They were working with the ripple tanks studying wave reflections and refractions. . . . When quizzed about their reading assignments, they also appeared to be well informed about what they were doing and the theory behind their experiments.

In most classes we observed from third grade through twelfth grade the students had few materials to manipulate, many materials to read and write on. The teacher explained some points and added a touch of personal experience, but spent most of the time directing the attention of the students to the information contained in the readings.

AVAILABILITY OF MATERIALS

More than 500,000 non-print instructional materials and an additional 5,000 print were marketed for use in the K-12 curriculum in 1976.* Of the approximately 2,800 textbook titles marketed for use in science, mathematics, and social studies, a relatively small proportion of that total were in use in a majority of the nation's classrooms.

The ten most-used materials in mathematics in the U.S. at this time were clearly traditional programs, all quite similar to each other in terms of instructional design and (although it is less relevant in this discipline) social and personal value systems. They were also traditional in terms of the way they were developed. Of these ten most-used materials, six were marketed by the same publisher. Among the first thirty-two mathematics materials listed in the EPIE Report, only one program was the result of non-traditional development, from a federally-funded course development project. This material ranked 24th, being cited by less than 3% of the EPIE survey's respondents.

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*EPIE Institute, EPIE Report, No. 76, New York, 1977, p 1.

Science almost followed suit. Just as one company published six of the ten most-used mathematics materials, so one company published six of the thirteen most-used science materials. However, among the first ten cited materials, and listed fourth, was a Regional Laboratory produced program that was demonstrably innovative and quite different from the other generally traditional materials. Although most of the ten most-used social studies materials were fairly alike, there were some innovative materials too.

We did not do a similar census of instructional materials at our CSSE sites, but we reached a strong impression that the schools were sticking with popular texts and workbooks. As stated above we were even more impressed by the centrality of these materials in science, mathematics and social studies instruction in all grades.

In Science. Elementary science appeared to be a "sometimes thing" at best in the curricula we observed. In BRT an elementary teacher reported her class was behind in science, ". . . because I'm not as good in science as in social studies where I do lots of map work" (p 4:51). Another story came from URBANVILLE where a science coordinator said:

> *Even though state law says teach science as a lab science, with so little money you have to teach it from the textbook. At the elementary level many teachers cannot teach science and many do not try.*

One of the "first things to go" was elementary science according to the story in COLUMBUS, the district which attempted to offer "school without schools" during the 1976-77 winter energy crisis. And in VORTEX we found elementary science reported to be in trouble because the old books were replaced.

> *The old books included everything--the whole science program. But today I feel the people who write the science books have lost all contact with children. You have to sit down and either read them to the children or the teacher gets up and tells the children what was in the first three pages.*

This last point is a telling one for elementary and secondary school science, social studies and mathematics. Some teachers at all grades called for better instructional materials for learners with reading deficiencies. Field observer Jacquetta Hill-Burnett noted (p 9:23)

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*One of our site visitors, William Dunkum, citywide science supervisor at Arlington, Virginia, was of the opinion that "the Pathways books are notoriously corrupt in terms of subject accuracy. The questions asked are frequently unconnected with associated chapters." The Pathways books were the first commercial, widely available, low-reading level high school science books of the late 1960's. Millions were sold nationally. They greatly contrast with most of the books produced by course content improvement projects funded by NSF.

Another low-reading level textbook is Concepts and Challenges in Science, Book 1, produced by staff members of the New York City Schools. According to site visitor Fred Rodgers, who earlier reviewed the book, "the informal, pictorial content still is greatly dependent on reading skills with concepts presented as new words (almost as if it is a vocabulary-development lesson) and not developed as ideas that have general . . . application. . . ."

"it was a special emphasis on word labels, definition of word labels and reading that made the sciences as dependent on reading skill as were the humanities." She found that "books that used the written word and paper and pencil to simulate inquiry and discovery were well received by the children," adding that "the Pathways in Science series was a favorite with every child I talked to."* Across all our eleven sites there was occasional indication that although the current materials were seen as unusable and that better ones could accomplish their goals, teachers' faith in the capability of materials per se remained high.

One of our URBANVILLE site visit team members captured a common impression of elementary science teaching (p 5:28):

> The treatment of science on the K-6 level is really nothing more than show and tell. This school district has had monetary cutbacks which have shortened the school day. Most of this day is spent with reading, writing, spelling, and arithmetic. Although the students really enjoy science, it can only be fitted in two or three times a week. There is no money for prepackaged materials so the teacher's preparation time for science is greatly increased which correspondingly diminishes the variety of lessons available. The teachers endorse a sequenced approach to science similar to the math program.
>
> I believe that the above described program is presenting the absolute minimum (if that) amount of science that is acceptable. Aside from the obvious problems of time and money, I feel the whole effort is suffering from a lack of rationale. Why teach science to children? What should we expect a third grade child to know about science?

Student-created materials were rare indeed in science and math. Even science fairs were in distress. Students, teachers, and parents alike were increasingly resistant to supporting extra-curricular activities besides sports and the budget crunch had school boards frowning on proposals to institute new programs or even to maintain old ones. In a few settings we found elementary science kits in use. Scattered instances of teachers using ESS, SCIS and SAPA were noted. In one junior high setting (FALL RIVER) we found locally created science packets. Four teachers met weekly to plan, revise and rewrite topical units called TREKS which Mary Lee Smith, the observer, found to be attractive for the students (p 2:15). High school science instructional materials were in similar shape. Textbook selection committee members in BRT were discouraged.

> *The science texts we looked at were very discouraging reading-wise. Just because of the vocabulary, but I guess this is necessary.*
>
> *You need good science authors.*
>
> *I think teachers would be more interested (in teaching science) if they had those books available.*

Similar faith in the textbook, the right textbook "if only it could be found," was expressed in PINE CITY. There and in ARCHIPOLIS, the text in high school science was the answer place for the teacher's questions.

The power of the text to dictate expectations was manifest in the PINE CITY student who said, "I'm small town. The books are written on a real high level" (p 6:38). An echo was heard in RIVER ACRES where one informant said, "You see here in the South I do not think we can take a book written by an Easterner and make our people handle it in the eighth grade" (p 1:101).

In half the high schools laboratory science was reported to be nearly impossible to conduct because the labs were run down or ill-equipped; some without gas or water in PINE CITY, some waiting over a year for ordered chemicals in ARCHIPOLIS. A time-space crunch vitiated much of science laboratory work. In BRT and RIVER ACRES teachers described the nearly impossible task of "setting up and taking down" within the constraints of an instructional hour. The PINE CITY impoverishment was not unlike conditions observed by a site visitor in ARCHIPOLIS.

> In Room 21 a crowd of young men and women were examining blood samples under a microscope--many people to a microscope, long waits in between lots of kill-time talk. (Empty rooms nearby testify to a more affluent past, maybe 50 years earlier when middle class whites sent their sons and daughters to this elegant school.)

The ALTE story was the one we all wanted to hear. Science education, robust, in place, active, "hands on." Texts and homework were seen as positively imbedded in a broad, rich science program. Readers who seek to read about science instruction thought to be among the best we documented should turn to ALTE.

A principal failing of science instructional materials from junior high school on was their presumption of mathematical understandings and skills by the students. The picture in VORTEX was one of uniform difficulty in all three junior high science programs with the math requirements in the physical science textbooks. Indeed, we found that, "mathematics is dominating the junior high school science curriculum" (p 10:11). But some teachers wanted even more. In those respective case studies we quoted a FALL RIVER high school chemistry and a RIVER ACRES physics teacher who longed for texts to support more advanced work. BRT teachers held high regard for BSCS blue and and PSSC Physics for their very best students. Detractors could be found, such as the FALL RIVER science teacher who summed up PSSC for him by saying, "NSF backed a real loser with that one" (p 2:7). But an URBANVILLE teacher spoke for most of our science teachers saying:

> *The NSF did a great service with BSCS, IPS, PSSC, etc. The shortcomings could be avoided in future works. Most teachers used the materials as they were. Then they "modified" them to suit their needs. Then, as books became outdated, etc., the modification increased. As the books are a great investment, replacements are hard to get. New versions can't be purchased.*

Even the temporarily radical COLUMBUS "deschooled approach" to teaching science and mathematics produced no noticeable curricular residue. When the schools went back in session it meant back-to-the books in science instruction. Although elementary teachers there were occasionally innovative in their teaching of science, the big problem reported for the teaching of elementary science was the transportation of one's own materials or borrowing those in a host school. At the secondary level, teachers reported considerable pressure to cover the material normally expected, and the typical method of instruction those three weeks was one of "hand in the assigned homework and we'll discuss it." Laboratory exercises were reduced to near zero (p 8:11).

> Reasons given varied but the two following were voiced frequently: (1) "Not enough time in one class period when you have to give assignments and collect papers": (2) "I don't want anyone coming from another school to start using MY laboratory and MY chemicals (or equipment), and I wouldn't go into another school and use another teacher's laboratory and use his chemicals (or equipment)." Communication and cooperation about equipment use needed to be encouraged and facilitated. One teacher felt that the administration should have mandated that each teacher mount a complete educational program. This might have included instruction, laboratory, help sessions, and evaluation plans. There was a recognized need for self-contained instructional units or packages. Such packages might include objectives, references, materials, worksheets, evaluation materials or activities.

In the Social Studies. What to do with the poor reader was the nut to be cracked in the social studies curriculum according to many teachers. "They can paint only so many murals," an elementary school principal quipped in RIVER ACRES. The importance of instructional materials was claimed by the senior high school social studies head in URBANVILLE.

> *"Our teachers do not need staff development. We need better materials, especially in U.S. History. . . . Curriculum reform has helped little; teachers face too many obstacles to change; ideas (are) good but nuts and bolts help is needed."*

Libraries and instructional materials or learning centers were found to range widely in their use. The ALTE high school library was described as "jammed" and its learning resource center "hummed" with student work. This in sharp contrast to the deadly quality of the junior high school libraries in RIVER ACRES or the playspace character of a BRT fourth-grade materials center. The mere provision of supplementary materials or presence of elegant technological apparatus guaranteed little. Note how even in ALTE "the road leads back home to the traditional worksheet" in this description by a site visitor.

> The key concepts in the school programming are individualized instruction, integrated subjects and electronic equipment such as head phones, tape recorders, TV, video taping equipment, and calculators. However, after observing in six classrooms in two schools for a total of about five hours it was noted that the majority of interactions of students, teachers and electronic equipment were around worksheets. Within this time period I attended two classes (fifth grade social studies and 4th grade science) which were planned as demonstrations for either visiting teachers or the principal. One had five minutes and the other 10 minutes with pupil/teacher discussion, utilizing the rest of the time for worksheets. These worksheets were to develop language arts skills while using the subject matter content of social studies and science.

In Mathematics. Mathematics teaching K-12 was almost exclusively focused on text materials. Manipulanda were used decreasingly up the grades and the texts were seen by many as too hard and confusing. VORTEX and RIVER ACRES teachers reported their belief in what good materials could do. Math lab teachers complained of seeing themselves as bookkeepers more than teachers, even while reporting success in their undertaking.

Individualization of mathematics instruction occurred to the extent that the same content was presented more slowly or rapidly as in WESTERN CITY, ALTE, RIVER ACRES. The outstanding example of apparently truly individualized mathematics materials may be found in the FALL RIVER report (p 2:18). Public controversy associated with one individualized instructional system (PLAN) was such that its educational merits probably were overshadowed. For a description of a different type of individualization and of a rare use of computer assisted instruction see the vignette of an elementary student doing a lesson on the University of Illinois PLATO computer system in the section on motivation in Chapter 15. Instructional television had sparse use due to the scheduling problems associated with the medium--particularly so at the junior and senior high school levels.

In VORTEX the lack of individual consideration in the "individualized" materials was revealed in this extract from a site-visitor's report.

> 1. Presently the top students are placed in Advanced Placement courses, the remaining students are somewhat haphazardly divided into classes of between 25 and 30 students. The lack of further grouping of students according to ability levels has created many difficulties; the better student becomes bored, turned off; the slower student becomes lost. Individualized attention is impossible because of class size. The problem becomes more complicated when one discovers that the same textbook is used for both the A.P. courses and the regular courses. There is little distinction of the degree of difficulty of these courses. The only distinction is the pace with which the material is covered.

Our study found but few traces of modern math. Some said it was dead. Some said it was stillborn; others that it had fatal genetic defects. It is probably wrong to say that it came and went. For most classrooms it probably never came. In URBANVILLE for example, conventional textbooks with 1960 copyrights were used in most classes (p 5:6). The sequence of instructional activity was seen to be the same in all classes. First there were the answers to yesterday's assignment followed by work at the chalkboard by the teacher or students of today's more difficult problems. New problems were then assigned from the text for the next day and the remainder of the period devoted to homework with the teacher moving as described in FALL RIVER (p 2:10).

In General. We did little to probe the procedures for changing and selecting course materials.* It seemed to teachers and administrators not an important topic. Some saw no leeway for changing, no money or no power--most felt that materials were not among the "big" problems.

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*Superintendents responding to our national survey reported that in 70% of the districts the school boards did not get more than minimally involved in the review and selection of science curricular materials.

The dependable packhorse of science teaching and learning was the material used to carry the instructional burden. It seemed to be doing the job most teachers, administrators, coaches, parents and students expected of it. The real struggles in the schools were elsewhere.

After all, instructional materials were budgetarily trivial. Far less than 2% of the average school district's budget was so spent. They were seen as dull stuff by most observers of education: who could create a poem, novel, or screenplay about the blossoming of a textbook?

But the recent EPIE survey revealed these monetarily trivial, topically dull things were crucial to science instructors in the U. S. Over 90% of the science teachers in a sample of about 12,000 teachers said their instructional materials were the heart of their teaching curriculum 90-95% of the time. Behind nearly every teacher-learner transaction reported in the CSSE study lay an instructional product waiting to play its dual role as medium and message. They commanded teacher's and learner's attention. In a way, they virtually dictated the curriculum. The curriculum did not venture beyond the boundaries set by the instructional materials.

Chapter 14

PLURALISM AND UNIFORMITY

A teacher on the eastern seaboard told us:

> *One minute it seems everybody wants the same thing.*
> *But the next minute it seems nobody agrees on anything.*

When we talked to a group of teachers or a group of students we were struck by the agreement they expressed as to how science programs and many other things should be. Each may have had a different way of expressing it, or picking up on different details of some "ideal" science program, but they usually pointed with unanimity to a number of large problems that should be taken care of.

DIVERSITY OF WANTS AND STANDARDS

When we moved from group to group or from place to place we found plenty of disagreement. On the more private responses to the questionnaire we found a diversity of views. A Washington teacher said:

> *I think it is important to keep in mind the need for children to have experiences which lead to creative thinking and deductive reasoning.*

and an Illinois teacher said:

> *We need to get right down to the nitty-gritty, the basics, the fundamentals rather than the aloofness, the abstracts. We're teaching abstracts now in the first grade--asinine!*

No reader would be surprised if we announced that from our case study reports, site visits, and national survey we could present a thousand pairs of quotations, diametrically opposed. That would not be proof that people do have different views or respond to different standards of value--for our respondents were reacting to different circumstances, as illustrated so well in the case studies.

In Booklet 15, the Executive Summary, we will contend that when people were talking about <u>educational needs</u> they were speaking more "relatively" than "absolutely", paying relatively more attention to the direction of movement needed to get away from a nearby bad condition, but not arguing that you could not go too far in that way of correcting things. It probably makes them appear to us to differ in what they want from education more than they do.

We wanted to know how our teachers and others in the field perceived the diversity of views of education. We put it this way in our survey:

> Parents, students, and teachers--talking among themselves or with others--say what they watn the schools to be doing. They say different things, but do they really disagree?

Each of the three paragraphs below has been said to be THE MAIN PURPOSE of our schools
Which do you think the schools should do?
Please circle one letter below each paragraph.

The HUMAN Purpose of Education	The KNOWLEDGE Purpose of Education	The CAREER Purpose of Education
The main responsibility of the schools should be to experience what human society is--the history, human values, work and play, the arts and sciences, what men and women have accomplished and what they have failed to accomplish. The schools should give students the opportunity to be a participant in the human experience, the aesthetic and emotional experience as well as the intellectual experience.	The main responsibility of the schools should be to help young men and women know all about the world. Each student should have maximum opportunity to study the basic facts and concepts of nature, technology, commerce, the languages, the fine arts and practical arts. The schools should help young men and women build skills for explaining--and even discovering--new knowledge.	The main responsibility of the schools should be to prepare young people for their life-work. Though most careers require training on the job and continuing education throughout life, the schools should lay the foundation for successful work. For students who will take further training in technical school or professional college, the schools should emphasize entrance requirements and preparatory skills.
THE STATEMENT DIRECTLY ABOVE TELLS US -- IN MY OPINION -- WHAT SHOULD BE	THE STATEMENT DIRECTLY ABOVE TELLS US -- IN MY OPINION -- WHAT SHOULD BE	THE STATEMENT DIRECTLY ABOVE TELLS US -- IN MY OPINION -- WHAT SHOULD BE
(a) THE MOST IMPORTANT TASK OF THE SCHOOLS.	(a) THE MOST IMPORTANT TASK OF THE SCHOOLS	(a) THE MOST IMPORTANT TASK OF THE SCHOOLS
(b) AN IMPORTANT TASK, BUT NOT THE MOST IMPORTANT TASK, OF THE SCHOOLS.	(b) AN IMPORTANT TASK, BUT NOT THE MOST IMPORTANT TASK, OF THE SCHOOLS.	(b) AN IMPORTANT TASK, BUT NOT THE MOST IMPORTANT TASK, OF THE SCHOOLS.
(c) A RELATIVELY UNIMPORTANT TASK OF THE SCHOOLS.	(c) A RELATIVELY UNIMPORTANT TASK OF THE SCHOOLS.	(c) A RELATIVELY UNIMPORTANT TASK OF THE SCHOOLS.
(d) A TASK THAT THE SCHOOLS SHOULD NOT UNDERTAKE.	(d) A TASK THAT THE SCHOOLS SHOULD NOT UNDERTAKE.	(d) A TASK THAT THE SCHOOLS SHOULD NOT UNDERTAKE.

After you have circled one letter under each box above please answer three more questions:

HOW ARE THESE THREE PURPOSES NOW BEING EMPHASIZED IN YOUR SCHOOL(S)?

the HUMAN purpose:	___only a little	___quite a bit	___more than the other 2	___far more than the other 2
the KNOWLEDGE purpose:	___only a little	___quite a bit	___more than the other 2	___far more than the other 2
the CAREER purpose:	___only a little	___quite a bit	___more than the other 2	___far more than the other 2

Table 14-1
Survey Item: Three Purposes of Education

14:2

..om 246 social studies teachers, parents and superintendents who responded to the question we received these responses:

18% said: People disagree fundamentally as to the aims and responsibilities of schools

63% said: People agree pretty much in principle, but disagree as to how to do the job

13% said: People really are pretty much in agreement with each other as to these things.

So it was clear, to us anyway, that most people do not see fundamental differences in the aims and responsibilities of the schools, but that they do disagree about the ways to deal with problems.

We asked the people in our national survey to indicate the priority that should be placed on each of three grand purposes of the schools. The three were: a human experience purpose, an academic education purpose, and a vocational employment purpose. The explication of these purposes is described on the following page. (Details of the results are in Chapter 18.)

For the moment the important survey finding to consider was that all but a very few of the teacher, student, parent, and administrator respondents cited all three as important purposes of the schools. Despite the outcry for more emphasis on the "basics" as described in the previous chapter, it was clear that other aims are still considered important by school people, parents and high school seniors.

As we listened to tapes of interviews and responses to open-ended questionnaire questions we were impressed with what we felt were fundamental disagreements. (Professors can, of course, be counted on to "discover" differences, or parallels, where no other can find the remotest trace of them.) We found many of the opinions expressions of personal or institutional ego, such as this from an editorial of THE WASHINGTON STAR (August 1977) on the findings of the College Board panel studying test-score declines:

> *"We suspect strongly that expressing something clearly and correctly--especially in writing--is thinking's sternest discipline." That finding, if nothing else of the report survives, ought to be engraved on every classroom wall in every public school--and perhaps printed as a legend on teacher paychecks.*

But we do not suggest that what people want should be dismissed because it is self-serving. On the contrary, the point is that it is important that schools provide educational programs acceptable to a diverse population--and that it would be inappropriate to rule out educational aims because they were self-serving, vulgar, or subject to disagreement.

As indicated a few paragraphs ago, it was not unusual for us to find group agreement as to school aims. In part, that was more an expression of personality than personal commitment. Quite a few do agree, and for one reason or another, others did not declare their disagreement, or they expressed it as an extension or refinement of what had already been said. Goal statements were kept at an abstract level. We could expect to find almost every one agreeing with Thomas Jefferson who noted the following objects of primary education:

To give to every citizen the information he needs for the transaction of his own business:

To enable him to calculate for himself, and to express and preserve his ideas, his contracts and accounts, in writing:

To improve, by reading, his morals and faculties:

To understand his duties to his neighbors and country, and to discharge with competence the functions confided to him by either;

To know his rights; to exercise with order and justice those he retains; to choose with discretion the fiduciary of those he delegates; and to notice their conduct with diligence, with candor, and judgment;

*And in general, to observe with intelligence and faithfulness all the social relations under which he shall be placed.**

just as we would expect them to agree with the objectives for elementary science education expressed in one school district (see Table 14-2.) The disagreement usually does not arise until the time devoted to these ends and the sanctity with which it is treated are not known. Then the pluralism of the beliefs in education becomes apparent.

Few readers would disagree that the American society is a hugely pluralistic society Many citizens yearn for an effective effort by the schools to reduce the heterogeneity of the young. Others wish that the schools would labor longer for the preservation of its subcultures. In the official documents and federal entitlements, today, multiculturalism has the edge. But the clearly dominant theme we have heard in most schools and classrooms, as expressed by the youngsters and elders there, was to bring up all the younger folk to be like those people who run each particular school.

"To model the new after the old" was not an often contested theme. It was not a volatile issue in most places, not, we think, because people really do agree, but because youngsters and oldsters, majority and minority folks, teachers and parents alike wanted the youngsters to share in the privileges and responsibilities of the people who now run the schools, and the banks, and the farms, and the factories. Most, it seemed, would indeed trade a birthright for a larger bowl of pottage.

Most would prefer the impossible--a preservation of their way of life, the honoring of old values, and affluence. When forced to choose most wanted their children to find good work, to have money, to be able to choose their way of life--only half realizing that once you commit yourself to a kind of work and a standard of living, what remains for most is merely the choice of whether to buy a boat or a sportscar.

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*"Report of the Commissioners Appointed to Fix the Site of the University of Virginia, etc.," in Roy J. Honeywell, The Educational Work of Thomas Jefferson (Cambridge, Mass.: Harvard University Press, 1931), pp 248-260.

Table 14-2
A School District's Elementary Science "Process Goals"

If our objective is to teach children to approach a scientific investigation in the same manner as a scientist, it becomes necessary to know the thinking processes used by scientists; however, no one method emerges as "the method" because scientists are as individual and different from each other as the rest of us. They have flashes of intuition, they resort to trial-and-error methods, they jump to conclusions and they plod through a wealth of facts and conclusions. However, it is possible to examine how they have refined their thinking and the mental processes.

The American Association for the Advancement of Science in a series of summer institutes with many scientists and science teachers, classified the thinking processes of scientists into schemes and levels.

These process goals are of equal importance to the understanding of the concepts of science and certainly of greater value to a student than the mere acquisition of a body of factual knowledge. The last five process goals stand alone in their cognitive meaning. The first five goals, however, are divided into levels of increasing sophistication.

Observation
Observation of objects, defining the properties of objects, grouping objects into some kind of order for a particular reason.

Communicating
Describing orally or in writing that which has been observed or investigated.

Measuring
Identifying, classifying, and ordering that which can be measured (time, length, volume, mass, density, etc.) and using or making instruments to accomplish the measurement.

Recognizing and Using Spatial Relations
Learning to transfer three-dimensional models into two-dimensional forms on paper. Understanding positions of objects in relations to each other both in fixed positions and when they are moving.

Inferring
Examining evidence and drawing some logical conclusions to what might have caused something to happen the way it did, although the causes may not be directly observable.

Defining Operationally
Simply, this means defining an event by telling what happens. Thus, a circuit defined becomes, "When I put the wires together the light bulb goes on."

Controlling Variables
This implies being able to define the variables first, then leaving one uncontrolled.

Formulating Hypotheses
Similar to drawing an inference. Tentative solutions to problems from observations made, about which some inconsistency exists such as some liquids layering instead of mixing.

Interpreting Data
Understanding what is implied by the data concerning the event, interaction or object which was observed and about which the data was collected.

Experimenting
Determining variables and controlling them in a specific situation for a definite period.

Heterogeneity. It would be difficult to support a contention that the student body as a whole was becoming more heterogeneous. The high school group has just passed its maximum size, but has shown no apparent indication of being the most diverse. The elementary school is nearing a minimum enrollment, but likewise is not apparently more or less diverse than in years past. There seemed to be no premium for individuality of expression, such as there was during the 1960's. Yet teachers are talking about the problems of teaching a heterogeneous class and looking for ways of making it less so. A teacher in GREATER BOSTON nodded toward one boy and confided:

> *He's a "special needs" student, with lots of problems--learning problems and emotional problems. I have to watch him because he might get into trouble because he doesn't know better. We have three or four such students in each class.*

The problem was a classroom problem rather than a district problem. Fewer classes it appears were organized around ability grouping though such grouping continues to be very common. Public Law 94-142 provides for the mainstreaming of handicapped youngsters, requiring that they be educated under "the least restrictive" conditions.

The community appeared to be upset by absenteeism from school. (Teachers in WESTERN CITY frequently mentioned it as a problem. Math classes there were listed as averaging better than thirty students per class, but field observations put it closer to twenty, p 7:14.) Rules against absenteeism may be tightening. The courts were limiting school-official use of expulsion as a punishment for student misbehavior. Absenteeism tends to reduce heterogeneity. We do not have good data on it but the classes may be becoming more heterogeneous--we know that is an expectation that many teachers have.

We asked our national sample of high school social studies supervisors, high school math teachers and elementary school principals whether or not increased heterogeneity of students as to learning ability and motivation is a problem for the classroom teachers. The question and the answers were as follows:

> For a number of reasons students in many classrooms are becoming (as a group) more and more heterogeneous in learning ability and motivation. Is this a major problem for teachers?

Portion of Sample Responding	Response: "Yes"	"No"	"I don't know"
150 of 201 High School Social Studies Supervisors	45%	20%	35%
92 of 150 High School Math Teachers	49%	23%	27%
57 of 94 Elementary School Principals	55%	37%	8%

(Percents are of people responding, weighted by sampling plan; standard errors in Chapter 18.)

> If this is a major problem, what should be done about it?

An elementary principal from New York City said:

> *Better teacher training, smaller classes, provision for grouping.*

A supervisor from Arizona said:

> *The problem can be helped by small group instruction within the classroom. Individualizing the program to meet the needs of the students*

within the group. Not using the same textbooks, materials and equipment for every child. The content must fit the needs of the student and be on a level they understand.

A high school math teacher from New Hampshire said:

I wouldn't want to see 10 different tracks for each area of student ability. Yet it does become difficult to teach if there is a wide range of abilities. Some students are bored; others are lost; and only a few are being motivated.

An unusual response came from a social studies supervisor in Ohio:

One answer is a carefully designed computer supported instructional program which could allow teachers to develop a curriculum for each student.

Most of the practitioner respondents who answered this question on our survey instrument indicated that ability-grouping, smaller classes, and use of aides were the ways to deal with such a problem. Several respondents apparently did not feel that there were constraints that limited the school in dealing with the heterogeneous classroom. One principal replied:

Obviously, become less heterogeneous and more homogeneous. (Stupid question)!

Even though some do not see the problems of making classes more homogeneous there was good evidence that heterogeneity is a pedagogical problem.

Special Education. The traditional arrangement in the schools has been to have the teacher give special instruction to individual children within the classroom, and to provide special rooms or specially trained teachers for instructing those who could not benefit sufficiently from or who would impede the group instruction. The arrangement is being called into question as indicated in subsequent sections. We were interested at our field sites in special programs provided in math and science for students to whom the regular program was not well accommodated. We were favorably impressed with a program at URBANVILLE arranged to permit wheelchair-bound students (from Hardy and other districts) to participate in regular classroom activities. Special remedial math classes were available there and in most of our CSSE high schools for "slower learners."

We asked math teachers:

> In your school what special efforts are made to help students who have special talent or extra interest in math?

From North Arlington, New Jersey: *They work on individual skill development kits, SRA algebra kits, math projects, lives of mathematicians, various games, and geometry activities.*

From Franklin, Tennessee: *Some of these students compete in a math contest sponsored by a university in our area.*

From Warren, Michigan: *Some can enroll in community college math courses.*

From Sheboygan Falls, Wisconsin: *In junior high we teach 6 different levels of math combining 7th and 8th graders in the same class if they have the same ability.*

From Rancho Cordova, California: *Computer programming*

And we asked science teachers the same question about science and were told:

From Tyrone, Pennsylvania: *They can act as science lab assistants.*

From Aberdeen, Maryland: *An advanced special studies program. My laboratory approach Physical Science is self-paced so that students may progress as far as their abilities take them.*

From Dundanville, Texas: *Participate in Westinghouse Science Competition and contests sponsored by colleges.*

From Durango, Colorado: *Knowledge bowl, field trips, special assemblies.*

We asked secondary school principals the following question:

> Every school has students for whom learning comes slowly and with difficulty. Is any special effort made in your school to help these students gain an understanding of science?

From East Brunswick, New Jersey: *There is a science program for everyone. IIS seems to do well by our slower learners.*

From Brooklyn, New York: *Reading in science--a reading class using science as the vehicle.*

From Benton, Arkansas: *A low level class in biology is offered to help slow students meet their biology requirements.*

From Minneapolis, Minnesota: *EMR and Special Education Resource Room*

The professional field of special education, relatively well funded by federal programs, has become highly specialized and technical. Increasing demand is placed on the specialist for classification of learning disability and specification of instructional conditions. These specialists seemed not to be involved in subject matter problems, such as what science to teach, at our CSSE sites. (A brief commentary on mainstreaming and PL 94-142 comes up in 3 or 4 pages.)

Engagement in Instruction. One parent from Atlanta wrote an unusual answer to our question about today's biggest problems with which the public schools must deal. He said: "teachers that don't do a day's work." The answer was unique. There is rather widespread agreement that teachers do carry a heavy workload. The critics we encountered faulted teachers for pursuing the wrong aims or for incompetence, almost never for lack of commitment.

Yet, for all the energies devoted to teaching, the quality of instruction was dissatisfying to many within and outside the schools. They saw it in many different ways. The answer to that question about the school's biggest problems ranged as widely as the sources, as the following examples show. But for the most part they collectively tell the many ways that prevent teacher and student from engaging in effective instruction.

Anchorage parent: *satisfying the public demand for the 3 R's--parents are fed up with youngsters not reading, knowing no history, not learning the hings they learned in school*

Hawaii student: *getting the students in school and set some sort of motivation for them*

Southern California science teacher: *community apathy; lack of support from district office*

Colorado Springs parent: *lack of basic educational requirements; lack of parent guidance at home in insuring a desire to learn*

Minnesota science teacher: *vandalism, apathy, reading, budget*

Wisconsin counselor: *fiscal support*

Akron student: *the student who doesn't try and yet complains about hard work*

Kentucky counselor: *drugs and the whole "welfare concept"*

North Carolina counselor: *lack of competent and innovative curriculum supervisors*

Newport News science teacher: *attendance, behavior, reading*

Western Maryland science teacher: *elected school board responds to pressure groups; too much spent on school construction, not enough for instructional materials; too many administrators, coordinators, etc.--this makes classes very large*

Suburban Philadelphia student: *social problems of students, such as drugs, pregnancies, run-aways, suicides. Let's face it, you're here to help train the kids; you might as well help them to completely fit into today's society.*

New Jersey parent: *Back to basics--competency in reading, writing, math, science and social studies--but not (as here) through regimentation and the resultant conformity for both teacher and taught. Seems to me that individualization and modular scheduling is a requirement for good education. The traditional system, of cource, makes it much easier to teach the SAT, impress the PTA, etc.*

The most common problems cited by administrators pertained to the testing of students. Students also most frequently mentioned problems (for the schools) having to do with testing. Curriculum supervisors more frequently cited fiscal problems. The teachers more frequently mentioned discipline problems.

We had expected more general identification of student discipline as a major problem for the schools. We recalled the results of the Gallup survey which had citizens naming it as the top problem.* We recalled recent cover stories of Newsweek and Time and stories in other news magazines and papers highlighting hostility and disruption in the schools:

> *Ask almost any teacher what he or she considers the top problem in the changing city classroom and the answer will be "discipline." (Newsweek, 9/12/77)*

We thought such stories might have crystallized the impressions of what the big problems were--but apparently not. There was widespread concern about misbehavior in schools, but it was not apparently seen as the "problem of problems" with our parent respondents or with others than the teachers. Not surprisingly, the teachers saw it more clearly as a major obstacle to providing good instruction.

Perhaps the most important academic aspect of the matter of behavior control was that time available for recitation and study was greatly diminished, perhaps even up to 50% in some classrooms, by confrontations between teacher and student, or between student and student, or the deliberate attempts of youngsters to distract individuals or the whole class from the lesson.** Some of it is contentious, much of it is devilish humor such as Mark Twain or Fellini would delight audiences with, but it aggregated, especially with some teachers and in some schools, to limit the students' opportunity to "do their lessons."

In an American history class in GREATER BOSTON one student interrupted the teacher's discussion of Roosevelt's program for economic recovery with: "May I interject? Who's going to the prom?" Later the teacher said she didn't like the lack of discipline but "a relaxed attitude was necessary to keep the school going." (p 11:48)

A cadet teacher in Illinois was confronted with: "You can't keep us [after school]. We gotta ride a bus."

It is easy to suppose, in our effort to be good researchers and good social planners, that the classroom should be a business-like place, sober and industrious. Many clearly wanted it that way; others preferred the natural ambiance of a good-working, happy-living family. In speaking of lack of discipline here we are not commenting that we have found little of the sober and industrious. In fact we found it everywhere. It was by far the

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*George H. Gallup, "Eighth annual Gallup poll of the public's attitudes toward the public schools," Phi Delta Kappan 58 (Oct. 1976): 198. We used the same language in our question and coded the open-ended responses according to the category labels Gallup reported.

**In Chapter 16 (The Teacher in the Classroom) we will describe more in detail how great is the effort of the teacher to maintain social discipline--often even in situations in which there is no apparent imminence of misbehavior--and to treat instruction in "proper behavior" as more important than instruction in "academic knowledge and skill." Cases of classroom "guerrilla warfare" are succinctly illustrated in the ARCHIPOLIS case study (see p 9:13ff).

prevailing atmosphere in the schools we observed. We found a large number of classes where there was a more informal, personal relationship, often spending less time on a common objective or exercise, but often engaged in the study of important and complex problems, of a scientific nature and otherwise. But we also found, as did Tikunoff, Berliner and Rist* that a great deal of the total classtime in any class was not spent on what it was scheduled to be spent on, that the classtime was devoted to administration and socialization. And that beyond that, in some classes a large portion of time was lost to confrontation and distraction. The increasing disability of teacher and school to deal with this problem is described in the following sections.

EQUAL EDUCATIONAL OPPORTUNITY

In 1971 policy analyst Thomas Green said:

> *For the next decade, and beyond, the attainment of equal educational opportunity will probably be among the most fundamental and intractable issues confronting American education.***

In the schools we visited in 1976 and 1977 the issue was not frequently discussed, but the quest for equal opportunity manifested itself in many ways.

Equal opportunity can be defined in different ways, the providing of equal financial resources, the providing of equal support of all kinds, the providing of whatever support needed to allow each who so chooses to reach a certain attainment, or the providing of whatever support it takes to guarantee that each attain at least a certain minimum. The difference is academic. The direction of improvement is obvious. So far most of the districts we visited have not moved beyond the simplest of standards, of equity--providing equal fiscal support. And well-publicized fiscal disparities were apparent to our observers within the impoverished schools of ARCHIPOLIS and PINE CITY and the affluent schools of BRT and ALTE.

It is not the fiscal provisions that concern us here but the more fundamental differences in opportunity to learn, involving the competence of the teacher, the quality of the learning materials, the learning place(s), the peer group of students engaged in learning.***

It appeared to us that the schools actually do quite well in providing a paucity of spaces and books suitable to the task. The teachers fell short of the ideal, especially in the poorer school but even there there were often the strongest of the ingredients. What

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*W. Tikunoff, D. C. Berliner, and R. C. Rist, An Ethnographic Study of the Forty Classrooms of the Beginning Teachers Evaluation Study: A-Known Sample. Technical Report #75-10-10-5 (San Francisco: Far West Laboratory, October 1975).

**Thomas Green, "Equal Educational Opportunity: The Durable Injustice." (Paper presented at the Proceedings of the 27th Annual Meeting of the Philosophy of Education Society, Dallas, April 4-7, 1971), p.121. Reprinted in C.A. Tesconi, Jr., and Emanual Hurwitz, Jr., eds., Education For Whom? (New York: Dodd, Mead and Co., 1974), p. 80.

***See, John Elliott, "The Problems and Dilemmas of Mixed Ability Teaching and the Issue of Teacher Accountability," Cambridge Journal of Education 6 (Lent Term 1976).

became obvious to us in these studies was that many of the poorer schools cannot provide a learner with a classroom of fellow students who can and will use a great portion of the lesson period for learning.

Please consider the revealing illustrations starting on page 9:13 of the ARCHIPOLIS case study. This would not be a typical classroom scene in ARCHIPOLIS, but neither it uncommon. We could present others from that same classroom where the students are fully engaged in learning. We could provide large contrast--though not so large in most--from any of our eleven sites. We could present others where it was merely a pocket of youngsters who withdrew from learning endeavors. The finding that we believe so important is that confrontation and loss of time were common in three of our eleven sites, enough so that perhaps half of the learning time in certain classes was thus dissipated, and that confrontation and loss of time were not uncommon in any of the districts. There are bound to be disagreements wherever people are in contact, and no enterprise is all business and no play--but playing and fighting were a major competition to teaching and learning in several of our CSSE schools.

Teachers in schools like ALTE and FALL RIVER were anxious to prevent such erosion of control (and scholasticism), even if it were to result in greater equality of opportunity. The bastion seems particularly threatened in a school such as the Bronx High School of Science, now facing a challenge by the U. S. Office of Civil Rights regarding its disproportionate enrollments of white and male students. According to a story by Marcia Chambers in the New York Times 7 November 1977, school officials and students are persuaded that high cutting scores on admissions tests are essential to keeping a high quality educational program for the city's academically superior students. Such a direct confrontation was not apparent in any of our CSSE schools, but the issue was just beneath the surface in PINE CITY, URBANVILLE, and GREATER BOSTON--and quite visible in ARCHIPOLIS.

Great effort has been made to increase educational opportunity by increasing the access of students to schools and classes that once were closed to them. Access for many lower-class and non-white children has improved but the quality of educational opportunity to them is neither equal to that for most middle-class white children nor satisfactory. Even among those who have supported desegregation on moral grounds we found little optimism that improvement in opportunity was likely to come through further desegregation efforts. Few teachers have an answer to the problem, but they are bent on helping out by increasing the efficiency of teaching, particularly for those who come to school with little scholastic preparation.

Traditionally the teacher's job has been to arrange the situation, to present the lesson, and to direct the activity of the youngsters. Recently, there has been increased attention to the quality of performance of the student, especially in "test" situations. The teacher has been challenged by parents and others: achievement performances are not good enough, and especially with so many things to be taught, the teacher should be more efficient in bringing achievement up to standard. The teachers were sensitive to the criticisms, and in fact have led the way in URBANVILLE and RIVER ACRES and elsewnere in calling for greater efficiency in teaching, that is, more "output" for a given amount of "input." Certainly, the new cadre of school administrators has encouraged them to honor "efficiency."

As suggested in the previous section, the teachers' way of getting better results, of being more efficient, is to group the students according to ability, to individualize instruction, and to use more rigorously defined lessons with specified criterion tests. The major obstacle, it often appeared, what works against these efforts to

be efficient and effective, was the student. Not just his poor background, but his lack of commitment to learning, his distractability, his defiance of authority,--hers too, of course. And these obstructions are not neatly contained so as to obstruct only the learning opportunity for that learner, but spill over to impede the whole class. The teacher looks for ways of intimidating or cajoling, often without success. The teacher seeks to isolate or expel the misbehaving student, often without success.

Mainstreaming. Governments, including the judicial branch, have not been content with the efforts of teachers to provide equal educational opportunity. In 1954 the Supreme Court turned down the philosophy of separate-but-equal schools,--ruling that a child was denied equal right under the law if, on the basis of race, the child was denied the opportunity to attend class with other children. The courts ruled that it was not only the obligation of the state to provide equal access, but to take initiatives, such as to bus children across neighborhood boundaries, to achieve integrated classrooms. One effect of these rulings was to increase the expectation that the students within a classroom would be a more heterogeneous group in many ways including experience, ability and aspiration.

Most teachers that we talked to were sympathetic to the effort to restore equal learning opportunities to the underprivileged, but were dismayed by the increased difficulty for the teacher and apprehensive about the future. They were seeking ways to make the teaching more efficient and felt the heterogeneous classes make it less so. The contention here, between equity and efficiency, is similar to a great economic debate cited recently by columnist David S. Broder (Washington Post, 10/26/77). Broder called the debate over oil and energy "a foretaste of the basic economic argument of the next decade," a debate pitting "equity vs. efficiency". He quoted John T. Dunlop, an economist:

> *If I were to pick out any single subject . . . as the challenge to this economy in the future, it would be the complicated problem of the interaction of the political process and the economic process and the different ways in which those two arenas tend to be approached. . . . the considerations of politics are centered very highly on equity, whatever that word means. On the other hand, the economy keeps talking in terms of efficiency, in terms of costs and benefits and such criteria. And those two are often very different worlds.*

The situation in education is similar. The professional concern is to get the lessons taught, to get children to learn, to move through the syllabus expeditiously. The political concern is to utilize the schools as an instrument of social improvement, to make life in the schools a more ideal life (politically) than natural forces provide in the private spaces of home and business, to guarantee that rights to an education and privileges deriving from an education are extended to all. And though equity and efficiency on occasion work side by side, each signals the concern of two very different worlds, and will sometimes be in confrontation.

The most recent obligation to return certain children to the mainstream of education has been in the area of special education. Public Law 94-142 is a comprehensive 1977 law for the education of handicapped children. It requires that these youngsters be taught in "least restrictive environments," with teachers not given final say as to whether a child can profit from the regular classroom, nor assured of assistance with the extra time demands and in-class distractions. We found teachers distressed by these prospects and administrators persuaded that the regulations were terribly costly and probably unworkable.

Tracking and Grouping. As indicated earlier, many teachers' answer to the problem of heterogeneity of students was homogeneous grouping (primarily according to ability) within the classroom if it can't be done by assignment to classrooms. The grouping would be primarily by scholastic ability but would consider motivation and activity as well. A biology teacher in GREATER BOSTON said:

> *The real problem here is trying to teach classes where some students want to learn, and perhaps plan to go to college, but where these students are mixed in with other students who don't much care and who took biology just because they like the idea of cutting up frogs.*
>
> *You can't teach to the level of the good students because the rest get bored and start disrupting the lesson and it gets so you can't like to let the scalpels out. And you can't teach to their level, because then the good students feel you don't care about them, and then they get bored and complain that science isn't really very interesting.*
>
> *The only answer I can see is to separate the two groups, so that at least you get those students who are interested and want to learn science in one group.*

The problems of elitism and equal opportunity are further developed in the continuation of this interview as reported in Rob Walker's case study on page 11:12ff.

When educators speak of "tracking" they usually mean the assignment of students into groups to be taught with different long-term objectives in mind, with their lessons to differ usually in complexity and comprehensibility of the subject matter. Once the students have been assigned to tracks it is not expected that they will return to a single track or the same group again for learnings in that subject matter. This kind of tracking was ruled an unconstitutional denial of rights in Hobson vs. Hansen, a landmark Federal court decision in Washington D.C. in 1967. It had been brought to court in order to admit black students to the advanced courses available then within the District largely only to white students. Our CSSE staff interviewed a few Washington, D.C. teachers with regard to the present condition there. They reported that as they saw it the courts had gone too far in keeping classes open, in requiring students to remain with their original heterogeneous groups, and particularly in requiring that problem children be returned immediately to the class rather than be detained in some way. The teachers we talked to were black, and saw themselves not as impeding the cause of civil rights, but as facilitating civil rights by providing a good education to those who would accept it, and keeping them unencumbered by those who would not.

"Grouping" is a term used (often in contrast to "tracking") to indicate temporary assignment to learning groups to facilitate study toward common objectives. Technically speaking, the members of groups can be returned to the class as a whole for further instruction in the subject matter. By good performance on subsequent testing any child might be reassigned to a faster learning group, thus the permanence of segregation by tracking is not built in. Restoration of a slow-learning or poorly-motivated child to the regular group can be difficult to arrange without postponing the next sequential assignment until the slower learners have had a chance to catch up. To insert some enrichment assignments may work, but it is an extra burden on the teacher and is seen by some parents as unnecessary delay, and in fact it is the introduction of different learning objectives to different groups, which was part of the definition of tracking. As it usually works out, homogeneous learning groups do differ with

regard to the pace of learning, with regard to the enrichments or breadth of learning,--and it is rare in most classrooms for a student to move from a slower group to a faster group. Yet homogeneous grouping is the best hope that educators have come up with for the problem of providing (at minimum cost) good learning experiences for children in heterogeneous classes.

We asked parents and principals how they felt about this matter, concentrating on the effectiveness and fairness of homogeneous grouping. The results:

	46 of 86 Jr Hi Principals		58 of 94 Elem School Principals		111 of 250 Parents of Seniors	
	n	%	n	%	n	%
Do you feel that grouping youngsters of similar skills and experience into learning groups or tracks generally makes instruction more effective?						
Yes	23	50%	31	53%	92	83%
No	10	22%	22	38%	16	14%
Other	13	28%	5	9%	3	3%
Do you believe it is unfair to some youngsters if there is sustained and heavy emphasis on such homogeneous grouping?						
Yes	32	70%	44	76%	58	52%
No	13	28%	13	22%	45	41%
Other	1	2%	1	2%	8	5%
Considering both teaching effectiveness and fairness, which is the best policy?						
Put youngsters into tracks according to their learning ability	5	11%	5	9%	33	30%
Don't use tracks but use grouping as much as is needed for good instruction	23	50%	32	55%	46	41%
Occasionally use groups for a short while: occasionally group dissimilar kids	9	20%	16	28%	25	23%
Except for very special activities, use no homogeneous groups for instruction	5	11%	3	5%	5	5%
Other	4	9%	2	3%	2	2%

(Percents are of those who responded, unweighted. Standard errors are not available.)

The two groups of principals responded the same, seeing grouping or tracking as making instruction more effective, and agreeing substantially that it can be unfair if sustained. The parents were somewhat more supportive of grouping, disagreeing as to whether or not it might be unfair to some. It can be concluded, we believe, that the potential effectiveness and potential unfairness of grouping was widely recognized. The compromise most favored appeared to be on the side of using grouping (but not tracking) as much as is needed for effective instruction.

One of the reasons* given for opposition to homogeneous classes was that it tended to increase the likelihood that a poor student would be assigned a poor teacher, as this Colorado computer science teacher said:

> *The real problem is with these students who would like to take additional courses in mathematics but are mathematically very immature. . . . Their needs are not being met. (Teachers are not motivated to teach this level.) College preparation does not prepare you to teach this type of student. (Those students get the worst teacher.)*

But the greater problem was probably the stigma of discrimination, expressed in an eloquent observation on pages 1:15 and 1:44 of the RIVER ACRES case study (it was in RIVER ACRES that we found the most carefully articulated grouping** operation):

> Students are grouped for instruction in mathematics from first grade through high school. In the elementary grades children are grouped for reading as well.
>
> In junior and senior high school the students are grouped in science and social studies too. By the senior year of high school there is an enormous difference between the top group and the second and third groups. Another sizable ability/achievement gap occurs between the third and fourth groups. It takes an exceptionally talented and dedicated student to do top group work in all subjects at Central High School according to students, teachers, and parents. Level One never comprises more than 5% of the class and is often less than that.
>
> Although teachers claim the average student is at grade level (at two grade schools) they feel deeply about their instructional ineffective-

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*Another potentially serious problem of grouping is the likelihood of reinforcing negative behaviors. For commentary on the interrelationships between academic and social grouping, see Phillip A. Cusick, Inside High School: The Student's World (New York: Hold, Rinehart and Winston, 1973). For an earlier review of ability grouping see Urban S. Dahllöf, Ability grouping, content validity, and curriculum process analysis (New York: Teachers College Press, 1971).

**Though the levels are prominent and acutely distinguished in RIVER ACRES, they are not "tracks." Any student requesting movement from level two to three or the reverse was honored, and also movement to and from levels one and four--if the counselor concurred (p 1:78).

ness for poor and many average students. It has nothing to do with science per se.

And a Texas junior high teacher made a profound comment to the case study worker in RIVER ACRES (p 1:44):

> *I have no earthly idea what they have had when I get them in the fall [Sixth grade]. The key to it all is placement. When we place 'em in the right level things go pretty well. [The counsellors do most of the placing of the students initially.] Level 1 really hums, level 3 is good for individualization. Level 2 is a wide mixture. They are so diverse. They could be 1's or they could be another "zoo."*

The "zoo" reference was to a particular group of level 3 students that had been exasperating each teacher who worked with them.

The core content of science instruction is similar across the three levels. The "Ones" get it all, and more. They can volunteer to be assistants to wash equipment, set up demonstrations and are allowed to use non-chemical non-flammable equipment. "Top-group competition is fierce," said one teacher, (and added):

> *We need a low-reading curriculum for the low Threes in science. I take level Two material and condense it for the Threes. They just don't care or they are LD [Learning Disability] kids. Some just can't work in a large classroom. So I cut out the details and just give them basic understanding, orally. Nothing in depth is possible. You can't plan for a level Three class in science. (Competition does not work). Just begin by talking and move on. (p 1:44).*

How spontaneous and challenging a science class experience in Level One can be is also illustrated on page 1:44 of the RIVER ACRES case study.

According to field observer Lou Smith, classes in the ALTE high school were grouped, not directly by counselor assignment nor by aptitude scores, but by sequential course prerequisites. In order to take a first course in physics a student was expected to have first taken or to be simultaneously enrolled in algebra, quantitative science, quantitative chemistry, trigonometry, and possibly "Biology Q." None of these ninth to twelfth grade courses in this sequence of prerequisites was in itself a requirement for graduation in ALTE. Therefore it was a most select group, though untracked, that was permitted the experience of the high school physics laboratory.

The ALTE high school math program was even more sequential than the science program. The social studies program (predominantly history) was less sequentially oriented. The classes as expected, then, were in mathematics more homogeneous and in history less homogeneous with regard to within-class student characteristics.

In the advanced math class at WESTERN CITY the following ethnic distribution was noted by observer Rudy Serrano:

> 15 Anglo students; 3 Oriental students; no Chicano or Black students;

whereas in a general math course the distribution was:

> 10 Anglo students; 8 Chicano students; 8 Black students; and no Oriental students (p 7:29).

The more homogeneous enrollments, such as the advanced math enrollments at ALTE and WESTERN CITY, are the delight of many high school teachers. They know students in these classes are going to learn an immense amount regardless of how good the teaching is--if the students do not refuse to learn. Most teachers who know how to keep up with such students do what they can to get such enrollments in the courses they teach.

Alternatives. One form of tracking that is not of questionable legality is individualized instruction. Many teacher , particularly in the area of mathematics see individualization of instruction as an approach that is both efficient and fair. At FALL RIVER's East Junior High School, the teachers

> decided to build an individualized math program as a way of coping with the highly variable math skills the students brought with them. The teachers examined published curriculum packages and visited school districts with a program they viewed as compatible, they asked the district office for money to support collaborative development. Once the program was developed, however, the teachers found that over half of the students could not work effectively on their own.
>
> This year they made an adjustment, starting with everyone (except the students who elected algebra), they reviewed whole numbers and fractions, then gave a placement test. The high ability and eager students were put into the individualized section. The rest were grouped by ability levels and taught in structured classes (p 11:18).

In this community there are elementary schools participating in PLAN, an indivualized computer-managed instructional program in language arts, math, science and social studies. The complexity of the advocacy and opposition to PLAN is nicely revealed on pages 2:20ff of Mary Lee Smith's case study.

Another way of dealing with the problems of heterogeneity of learners is the use of learning centers or learning labs, special rooms with special teachers and special materials. In VORTEX Gordon Hoke talked to a young man named Joseph who directed a Math Lab in one of the elementary schools (pp 10:11f).

> I raised a specific question concerning the level of test diagnosis, referring to a study conducted by one of our research assistants who concluded that gross difficulties, which teachers already grasped, were the main product of test utilization, with instructors receiving little aid in pinpointing a pupil's idiosyncratic needs. Again, Joseph remained steadfast in his praise of the test materials.

His testimony was important because it reflected a dozen years of mathematics instruction in elementary schools plus seven as an instructor in the VORTEX Basic Skills program. Joseph then explained:

> *We work around their schedules as much as possible. Don't want to create "hostile" kids because those who come in here have a history of failure, after all, that's how they get here. The lab is not "instead of" but is "an addition to." Our focus is strictly on the individual and his need for skills improvement. The "Company" has urged us to do more small group work at the table here, but I'm opposed. We do combine episodes with the hardware with pen and paper reinforcement drills, but our main purpose is to make this period as different as possible from normal classrooms.*

Even though an affluent, self-sequestered surburb, our site at ALTE also enrolled a heterogeneous student body. A single curriculum, and even a single high school, was insufficient to handle the diverse aims and backgrounds of its people. With 90% of the students going on the college, the student who would be an ordinary student elsewhere was in a minority there. In ALTE they called them the "silent majority"--though they were neither. Special courses were arranged for them. In the slow algebra class our observer saw 15 students, 12 following the teacher through the intric s of quadratic equations, three of them "tuned out," perhaps unable to keep up. rding to Lou Smith's notes a science teacher was moved to say (p 3:100):

> that the courses in the science area at ALTE were too difficult for some students in the school. . . . said the entire curriculum was designed to make the student think critically. Some could not. There was nothing for these students. . . . felt that something should be done for these students.

In 1972 an "alternative school" was set up in ALTE (p 3:101) because

> a significant number of students, both academically able and those with problems, have expressed a desire to "drop out" unless something broader and more immediate is offered.

At the alternative school as many as five per cent of the ALTE high school students could take a special program. The observer noted the social sciences there being (p 3:102):

> more oral and less bookish, more immediate and practical and less remote and theoretical, more group-involved and less individualistic, than social science at the high school.

Whether or not the alternative school program was a suitable program continued to be debated across the community. Our observer found the issues about the alternative school intimately related to the question of whether or not a school system should honor the pluralistic disposition of the community--one that appears to many outsiders as extremely homogeneous.

Alternative schools have been dismissed by many analysts, partly because they leave such little record of accomplishment and partly because they have had in many places a short life span. Neither is a good basis for evaluating their worth. A more careful look at them, such as one proposed by educational philosopher Mary Anne Raywid of Hoftra University*, is needed, particularly as new forms of alternative schools such as the fundamentalist and basic skills alternative schools are established. It has been suggested that the alternative school is an escape valve for youngsters or parents who reject what the system has to offer. They need also to be looked at as an escape valve for the system, that is, a device that permits them to continue functioning as they have in the past. Other alternatives, such as open enrollment, optional types of report cards, and teacher option curricula are also suggestive of this.

A more modest form of alternatives to the regular school is that that takes traditional programs and links them together in new ways, keeping science as a part of the academic program but capitalizing on the vast--and often unexpected--opportunities for learning in everyday living. In PINE CITY observer Rob Walker expanded on such a form (pp6:23f):

> . . . I had in mind a vision of an alternative pedagogy I think shared by many science educators. In fact it's more than a vision because you can see it in action not more than a few minutes walk from the classroom in the Trade School, and perhaps particularly in the Auto Shop. . . . The teacher is available as organiser, consultant and supervisor rather than as curriculum ringmaster. . . . The students in the Auto Shop work as essentially apprentices rather than as clerks and collectors of information.

Ironically, praise for the Trade School and its teachers spotlights the history and influence of a dual school system in the South. For the facilities and instruction were originally identified with an institution where members of the segregated student body were prepared solely for the world of work. Desegregation had brought heterogeneous classes and new options for both white and black.

Our site visitors also were impressed by the vocational programs in PINE CITY, paying special tribute to the integration of metrics with conventional assignments. During the week of the visit PINE CITY's elementary schools were featuring ties between science, nutrition, and eating habits: bulletin boards, corridor signs, and classroom decor carried the messages.

In a section termed "The Voices of Students," (p 6:30), Walker recounted the experiences of several Pine City youth trying to interpret the meaning of their lives in this rural setting.

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*Project on Alternatives in Education, "The PAE Story," John Dewey Society, (Columbus: Ohio State University, May 1977).

Tony, a seventh grader, "loves the outdoors and spends much of his time fishing and hunting." The observer quoted Tony as saying: "Science is not easy, there's a lot of studying, but it is interesting." The boy is an avid viewer of Cousteau films and Wild Kingdom, and thinks he would like to be a marine biologist. Tony is very observant, we were told, an eager collector of information. "When you go out in the woods you never quite know what you will find," he told Rob Walker. Rob concluded by stating that

> fishing specially is almost a science to Tony. . . . He seems to store each of [these] facts away in his mind as he encounters them, and enjoys the opportunity of talking to knowledgeable adults about them whenever he gets the chance.

The "chance," whether it comes from participation in an outstanding classroom or through encounters with resources in the larger environment, is not easily arranged. Walker succinctly phrased the challenge facing educators when he finished his brief tale of the shop classes by writing:

> It is possible for science too to be taught along these lines. . . . but like the Auto Shop it would require the provision of space and equipment as well as special kinds of teachers.

The community has been as much a barrier as an opening to opportunity. Jennifer, a PINE CITY graduate nearing the completion of a two year college program, cautioned us (p 6:42):

> *There's a big red line [of segregation]: some restaurants will not serve blacks there are two community centers--one black, one white; and a number of jobs still closed to blacks. They have a line, and it's going to take some pushing to get past it.*

Jennifer, we were informed, was one of five black students enrolled less than ten years ago by parents in an all-white sixth grade--under a new doctrine they called "freedom of choice."

Whether or not the alternatives suggested here do in fact contribute to equal opportunity of education is not at all apparent. What they do satisfy in many instances is the felt-need for a better opportunity. Again the question arises as to whether it is the school's responsibility to provide instruction that will satisfy a court's standard (or a researcher's or philosopher's standard) or whether it is the school's responsibility to satisfy the expectations of students and parents and other citizens.

ARTICULATION OF TEACHING OBJECTIVES

Faced with a diversity of expectations and standards, a sometimes trying heterogeneity of students, and continuing claims of inequity in educational opportunity, the schools have sought to hammer out agreement as to their high priority responsibilities. People in and out of school have generally agreed that it is

important to be more explicit about goals--for diverse reasons. We asked principals, supervisors and parents the following question:

> In one city recently science teachers in elementary, junior high and senior high schools expressed a strong desire to clarify what should be taught in each grade. What do you think are major reasons teachers seek such clarification? (Check one or more)
> ___to make their jobs more manageable
> ___to locate the blame when deficiencies were found
> ___to make clear to students what is expected of students
> ___to persuade Board and Community to support some areas better
> ___to select the best text materials from the huge supply
> ___the reasons are different from community to community
> ___there really are no reasons; maybe it's just a panic response
> ___other (please specify

The responses† were as follows:

HIGH SCHOOL PRINCIPALS 54 responding of 87 sampled	ELEMENTARY SCHOOL SCIENCE SUPERVISORS 134 responding of 210 sampled	PARENTS OF HIGH SCHOOL SENIORS 142 responding of 250 sampled	
52%	50%	44%	__to make their jobs more manageable
22%	11%	23%	__to locate the blame when deficiencies are found
61%	59%	51%	__to make clear to students what is expected of students
11%	7%	20%	__to persuade Board and Community to support some areas better
32%	35%	33%	__to sleect the best text materials from the huge supply
35%	25%	25%	__the reason is different from community to community
2%	4%	7%	__there really are no reasons; maybe it's just a panic response
17%	21%	5%	__other

†Percents are unweighted percents of those responding. Standard errors are not available.

Statements of objectives. For several years teachers have been engaged in writing or choosing course objectives--constructing lists or matrices of aims, topics, competencies and desired student behaviors. They have sought consensus with community blue-ribbon panels, student councils, parent-teacher organizations and others with interest in what will be taught. The aim has been to fix upon a school program that would be acceptable to all concerned.

Full agreement is hard to find. For the most part committees have operated in good faith; considering majority and minority views; acknowledging unique local conditions, teacher perogatives and individual differences among students. But they have felt compelled to each consensus. One usual result is for the statements

to be made up of global and non-controversial aims. We heard a few interviewees at our CSSE sites complain and we wondered generally if people had misgivings about these statements being overly simplistic. We asked our national questionnaire respondents about the following claim:

> Authorities are urging teachers to be more specific about instructional goals. If curriculum guides and lessons do get much more specific, the curriculum will over-emphasize simplistic skills and memorization of isolated facts.

Percent of people agreeing with the claim:

	Large city >100,000	Large Suburban	Non-Metro ≤100,000	TOTAL	Number Responding
___ Teachers	36%	58%	44%	44%	176
___ Curric Supr's	74%	32%	40%	41%	229
___ Administrators	93%	42%	21%	38%	75
___ Students†	39%	37%	42%	42%	242
___ Parents †	46%	41%	18%	18%	133
	West	Midwest	South	Northeast	
___ Teachers	54%	42%	28%	42%	
___ Curric Supr's	60%	35%	51%	35%	
___ Administrators	56%	37%	26%	4%	
___ Students†	57%	47%	57%	46%	
___ Parents †	29%	37%	43%	39%	

Standard errors are not available for these weighted percents.
†unweighted percentages are used for students and parents

Teachers and curriculum supervisors in many districts have gone on to specify further the more detailed immediate objectives, lesson by lesson, the steps to be taken to accomplish the larger aims. The galaxy of facts and operations that constitutes even an average eighth grader's education of course greatly exceeds the catalogue of specific objectives in any school program. Most teachers have a tacit knowledge of how complex and personal an education is, and each works to further those many educations--but many teachers find it difficult to justify time spent on personalizing classroom learning. It is so much easier to justify time spent on those several objectives specified in the syllabus. As greater stress is placed on teachers, they increase their attention to the specified aims, for good or ill. Many teachers believe the movement to pursue common specific objectives should be speeded up; some object. But the movement was apparent in all eleven CSSE sites, and from questionnaire returns from all fifty states. It is a movement well integrated with the movement toward a fundamentalist (basics) curriculum.

Uniformity. In our interviews we asked about the desirability of having each school district, or each classroom, or each child, work toward being the mirror image of each other. Of course our respondents found the idea abhorrent. (Cloning is so objectionable that it has worked its way well into American humor.) But we were surprised that so many espoused these lists of common goals and urged a greater uniformity of instruction. Of course, it does not mean that they really want uniformity, perhaps only less diversity than they see around them now. Nor did they apparently mean they want uniform standards when they said they wanted more uniform standards.

It is obvious that the language a person uses or the knowledge a person has may be quite acceptable for one circumstance or one locality and unacceptable for another. As they grow up, even in a mobile world, most learners tend to move in limited circles, circumstances and localities, infrequently crossing over to where a different language-competence or knowledge-store is demanded. It is easy to see that whatever is a "minimum" competence in one life-space may not be in another. Actual norms or standards in arithmetic ability, reading ability, and knowledge of science specifics vary tremendously from person to person. We know this from our experience, and we confirmed it as we talked to lay and professional persons across the country.

How then is it possible for parents and teachers in our middle eastern seaboard community to state so fervently and unequivocally that we need to make the curriculum more uniform from school to school, from classroom to classroom--so that all children are learning much the same and are more nearly alike in their readiness to encounter new learnings? One of our team visitors to that site, curriculum specialist Fred Rodgers reported back:

> Another factor in the improvement of teaching quality is related to establishing what teachers and learners should accomplish as a result of their efforts. While most participants agreed that accomplishments should be broader than narrow specific behaviors and outcomes, they felt that working toward some known and acceptable objectives was helpful and needed. Without such a specification of objectives, most participants felt that it would be infinitly more difficult improving the quality of teaching . . . and institutionalizing expectations (Site visit report).

A principal of an URBANVILLE school was entirely in sympathy, citing lack of uniformity as the number one problem to be worked on.

Scenario T. A feeling that there should be better articulation of goals, prerequisites, and course activities was apparent in all our eleven sites. We prepared the following scenario to explore the issues discussed in this chapter in the communities of our national sample. We presented the following scenario to high school principals, elementary school science supervisors, and parents of high school seniors.

Scenario T

Please consider the following "correspondence"

Dear District Administrators,

The PTA-Council is thinking that it would like to set the theme for next year's meetings as something like "Putting the Curriculum in Uniform." We want to stress the need for uniformity of teaching across the district and the need for encouraging learning that leads to good employment opportunities. Please let me kn your reaction to this tentative choice.

Respectfully, Willa Petrun, President

Dear Mrs. Petrun,

You will be hearing from others on the staff. For myself, I am pleased with your choice. Discussion of this theme will help draw attention to our objectives-based curriculum and the importance of providing equal opportunity for learning in each of our schools. If we are going to be fair, we must be uniform.

Sincerely, Jarvis Shattuck, Superintendent

Dear Willa,

I look forward to working further with the Council. I think the title, "Putting the Curriculum in Uniform," is corny and hope you find a better one, even if the topic is "uniformity."

I am disappointed, I must admit, that you did not choose the theme sponsored by Mr. Perez, "Where is our Science Program?" I feel that more emphasis on uniformity is going to further erode support for our college-prep program. We have lost support from the Board because we do not have their endorsement on a set of objectives for the sciences. They don't fund what we don't specify. I hope that the Council will give Mr. Perez's proposal further review.

Your "favorite" science teacher, Foster

Dear Ms. Petrun:

Thank you for giving us the opportunity to influence your consideration of themes for next year. In as much as the state legislature will be voting on bills to create a Competency-Based Diploma, I think we should review our entire philosophy of curricular uniformity in the district.

Uniformity could be an obstacle to providing an educational program tailored to each student's home-culture, talents, and aspirations. Uniformity could diminish the flexibility we have had in our alternative school and our magnet school. We should be discussing uniformity this year, and of course, we should recognize that too much of it can be as troublesome as too little.

Yours truly, Mavis Cooper, Principal, Central School

Scenario T continued

1. These letters summarize some of the concern about the curriculum. Some people are wanting courses to be more uniform, so that, for example, all sixth grade math courses and all American history courses are alike. What do you think about it?

of 53 High sch Principals	of 129 El Sci Supv's	of 138 Parents	
23%	21%	41%	___I think that much more uniformity is needed
45%	45%	41%	___I am opposed to a high degree of uniformity
19%	22%	14%	___I would like more uniformity, but getting it will cause problems too
13%	12%	4%	___Other: (please explain):

2. Superintendent Shattuck implied that the same courses in different schools have to be alike if the school system is to be fair. Do you believe this is so?

Our responding high school principals, in a ratio of about 3 to 1, responded "No," adding such comments as

"Backgrounds (ethnic, economical, political, etc.) are not all equal. Maybe more emphasis on "water" courses in Hawaii, (something else) in Idaho."

"I believe this ignores the reality of what education is and the reality of rapid change in our time."

"Someone has said that equal opportunity for unequals is not equality. No, I know that these courses should not be alike."

"Basically yes. Methods may vary, but course content should be essentially alike."

People having responsibility for coordinating the science curricula in elementary schools, in a ratio of about 3 to 2, also responded "No," adding such comments as:

"No, individual differences can be rectified by using competency based objectives for each school."

"Yes, if the different schools are part of a large unit, e.g., the schools of Cleveland, then they should have uniformity."

Scenario T continued

However, to the contrary, parents of seniors, in a ratio of about 3 to 2, responded, "Yes," adding such comments as:

> *"The only difficulty is when a student transfers from one school to another. The curriculum should be uniformly based with the same text--but classes should be tailored to student needs, not alike--still, two junior highs feeding the same high school should have a similar curriculum."*
>
> *"I do wish all the school systems were taught on the same level."*
>
> *"Not at all. 'Fair' should not be an objective of a school system or a curriculum. Educated graduates should be the objective."*

3. In your own community, generally speaking, ...
...how large a voice do parents have in school goals:

Of high school principals	35% said "large";	59% said "small";	4% said "none"
Of science supervisors	36% said "large";	58% said "small";	5% said "none"
Of parents of seniors	24% said "large";	66% said "small";	10% said "none"

...do school officials respond as these three did here?

Of high school principals	60% said "yes";	23% said "no";	17% said "don't know"
Of science supervisors	54% said "yes";	21% said "no";	25% said "don't know"
Of parents of seniors	32% said "yes";	20% said "no";	48% said "don't know"

...do most parents want more "uniformity" across schools?

Of high school principals	50% said "yes";	17% said "no";	31% said "don't know"
Of science supervisors	55% said "yes";	13% said "no";	33% said "don't know"
Of parents of seniors	39% said "yes";	13% said "no";	47% said "don't know"

4. Do you agree with the concerns Mavis Cooper raised with regard to "uniformity?"

Of 52 high school principals	89% said "yes";	8% said "no";	4% said "other"
Of 130 science supervisors	80% said "yes";	17% said "no";	3% said "other"
Of 137 parents of seniors	66% said "yes";	25% said "no";	9% said "other"

Scenario T continued

5. Foster seems also to be suggesting that the science curriculum is competing with the objectives-based curriculum--rather than being supported by it. Do you feel that funding for the one, if spent properly, would support the other? Or do you feel that districts just have to make hard choices between traditional and objectives-based studies?

of 47 High Sch Principals	of 126 El Sci Supv's	of 123 Parents	
13%	9%	43%	...The methods and goals of traditional and objectives-based curricula are relatively independent; therefore, they compete for funds.
81%	86%	53%	...The methods and goals of traditional and objectives-based curricula are highly related; therefore, they do not really compete for funds.
5%	6%	4%	...Other (please indicate):

6. Do you agree with Willa Petrun that schools should give more emphasis to studies that lead to employment opportunities?

Of 52 high school principals	77% said "yes";	13% said "no";	8% said "I don't know"
Of 129 science supervisors	68% said "yes";	23% said "no";	9% said "I don't know"
Of 134 parents of seniors	80% said "yes";	16% said "no";	4% said "I don't know"

(The original sample sizes were: 87 high school principals, 210 elementary science supervisors, and 250 parents of seniors. The percents reported for Scenario T are unweighted percents of persons responding. Standard errors are not available.)

Vertical and Horizontal Articulation. As detailed on page 5:27 site visitor Howard Levin saw the URBANVILLE schools as having

> absolutely no articulation between the three major grade units (K-6, 7-9, 10-12) and very little articulation between classes within a unit.

Curriculum coordinators, facing the difficulties described on p 15:12, often try to get firm commitments from teachers at successive grade levels to improve the sequencing of courses, i.e., to get the curriculum better articulated vertically. Teachers agree, when asked directly, as shown in the following responses to one of our survey questions:

Here is a common claim:

> Students would get a better education if there were regular discussions and firm curricular arrangements between teachers at different grade levels.

Percent of people agreeing with the claim:

	Large city >100,000	Large Suburban	Non-Metro <100,000	TOTAL	Number Responding
___Teachers	83%	70%	72%	75%	177
___Curric Supr's	96%	88%	96%	93%	238
___Administrators	76%	77%	68%	60%	77
___Students	64%	60%	69%	66%	248
___Parents	83%	79%	68%	75%	140

	West	Midwest	South	Northeast
___Teachers				
___Curric Supr's				
___Administrators				
___Students				
___Parents				

Standard errors are not available for these weighted percents.

And the response of a high school teacher at BRT is typical (p 4:9):

> *It's really helpful to find students coming to class prepared for science by their past experience. Mr. O (the junior high science teacher) and I meet as often as we can. At the end of some teacher-workshop days we get together. We've worked a lot with chemicals and such 'cause a lot of things he doesn't have. So we share back and forth. This is all informal.*
>
> *But a few years ago when the state superintendent required all the schools to prepare objectives, we met frequently. This forced us to look at what we were doing. We tried not to be so repetitious. That's when we decided to offer some semester classes--botany and zoology, and to not require biology; because they get quite a bit of biological background in junior high. I've tried to encourage more of the students to take chemistry because Mr. O doesn't cover that as heavily.*
>
> *The primary people were also involved, but most of them don't do too much with science. Some do more than others. There's a lot more important things the primary grades must do. At least once a year, though, we try to get each primary class down here to the*

science rooms. I set something up for them to do. One year we had two living frogs that we tried to let the kids feel and touch. I couldn't hold on to them and we had frogs going all over. The kids thought it was great.

In URBANVILLE and everywhere we heard the traditional complaints:

> High schools say that junior high schools do not prepare students, the junior high schools complain that the elementary schools do not prepare the students and the elementary schools complain about parents.

With such longing for better preparation it seemed natural to expect teachers to be spending regular time and effort to coordinate their work with teachers above and below them in the sequence. They didn't. Partly, they said, it was a matter of time, but also a disappointment with the results of such efforts. They were quick to point out that teachers at other levels were not sympathetic to the job they had at their level, as another URBANVILLE teacher told a site visitor:

> *...the high school science teachers have asked why the junior high science program does not prepare students in specific areas. We get upset and say, "Don't dictate to us what we are doing down here."*

What seemed so natural to almost everyone is to get widespread agreement as to the goals at each level and to allow freedom for each teacher to attain those goals. The same teacher went on to say:

> *I'd feel very tolerant towards a structured curriculum if it were appropriate to balanced basic-education. Structured goals, nationwide, K-12, but leaving it open to each teacher to use his creativity in developing and meeting these objectives, and enough resources, tapes, films, film strips, speakers, exchanging ideas--it would be fantastic. It's also important to have a nationwide testing program (not competitively based). Then we'd have some continuity.*

Many teachers seemed to underemphasize the pressures that could arise to remove teacher creativity and options when the test results were not satisfactory.

Articulation does not require detailed specification of objectives. Visiting a bustling Outdoor Education program at one of our CSSE sites, science education professor Clifford Anastasiou said:

> [This environmental education program] is perhaps the ideal example of articulation in the school district. All levels are represented on the planning committee. Even non-district consultants sit in with the Environmental Education Steering Committee. The thread is complete and its results are evident.
>
> [Elsewhere in the district] the problem of articulation represented itself immediately with the complaints, not only of teachers, but also the students. While at least one junior high teacher was concerned with the preparation provided by the elementary program, the students were almost unanimous in decrying the lack of basics in their elementary math program. At least one student placed the blame

squarely on the IPI program, which in his view did not provide opportunities for drill on the basics of addition, subtraction, multiplication, and division.

It seems easy to blame lack of articulation for failure of instruction; it presumes that the teachers are teaching something, but the wrong things, and it presumes that the students can learn and go on to an education-enriched life. One cannot read these case studies, however, and conclude that organizational rearrangements will remedy the problem. Consider the words of a teacher trainee working in the math department of our high school in GREATER BOSTON (p 11:16).

> *I came here thinking that Trig would be the course where I would really be teaching Math, but I find the students have such a poor background in Math that I'm really not teaching Math at all. When students don't know how to multiply fractions there seems little point in going on with cosines and tangents, so much of the time I am doing basic Math with them, even though the course is called Trig.*
>
> *I worry about the long term consequences of doing that, but the subject is fundamentally sequential. There's no point in going on until you have mastered each stage. I've tried individualizing things for the students so that those who are ready can move on, but it soon gets very complicated, and I feel from the teaching point of view I need to keep them together as a class as much as I can.*

What have those youngsters been doing in all their pre-Trig math classes? It seems farfetched to blame lack of articulation, or errant teachers, or new math. The remedy must be more fundamental. Could it be that our own expectations of education, particularly in the urban school, are part of the problem? Could we be emphasizing preparation too much, rather than too little? We asked 198 elementary school math supervisors and 150 junior high math teachers about their beliefs about the emphasis on "preparation." (111 supervisors and 79 teachers responded.)

Most seventh grade teachers are disappointed with the skills and knowledge children have when they arrive in September, finding them not ready for seventh grade lessons, needing relearning or even new learnings to get them ready. And so with the sixth grade teacher, and the fifth, and so on down. Is this not so?

> 85% of elementary math supervisors said, "This is the way it is."
> 70% of our junior high math teachers said, "This is the way it is."

Most teachers assume that it is their responsibility to get children ready for the lessons of subsequent years. Is this not true?

> 79% of our elementary math supervisors said, "It is true."
> 82% of our junior high math teachers said, "It is true."

But, examining their own lessons, the projects they assign and the learning experiences their pupils are having, many teachers recognize that they have much broader aims than just getting the youngsters ready for next year's learnings. It distresses them to think of diminishing the broader aims in order to spend more time on the particular skills and knowledge the next teacher may require. Is this not so?

> 63% of our elementary math supervisors said, "That is the way it is."
> 44% of our junior high math teachers said, "That is the way it is."

How do you feel? Should most math teachers reconsider the lessons, the projects, and the experiences in their own class toward the purpose of getting youngsters better prepared for the lessons of the next year?

41% of our elementary math supervisors said, "Yes, definitely."
but 49% of them said, "No, the broader aims are important too."

51% of our junior high math teachers said, "Yes, definitely."
but 34% of them said, "No, the broader aims are important too."

Percents are unweighted percents of those responding. Standard errors are not available.

From marginal comments and from our interviews we know that many respondents want to say, "do both." But something has to give. The teachers are not "goofing off." Most would be doing more of both if they could. Right now they feel that a more focused, more basic-skills-oriented curriculum, well specified and articulated, would help. Yet we see problems wherever a district or state has tried to institute a more structured, a more regimented instructional system. There seems little promise in that popular answer. After taking a look in the next chapter at the student's learning, we will come back to these classroom problems with greater attention as to what the teacher was doing with learners who were in difficulty.

And a few more words about sequencing. There probably are optimal sequences for teaching many things, and the optimal paths are probably about what teachers and instructional analysts tell us; but the sense of marked difference (that a few of them have) that it makes to follow one sequence rather than another is not based on evidence that is apparent to us. It is reasonable to suppose that some of their conviction about "the best path" is based upon their own great distress at failing now to teach learners what earlier or elsewhere seemed relatively easy to teach. It is not a sure thing that these children, with the present learning environment, would be learning better now if they had a different sequence of lessons.

A curriculum could become more tightly sequenced and non-redundant than it should be. Students move from school to school and from city to city. They become sick and go on vacations, they skip school. They need to become familiar with redundancy, misalliance, and contradiction--one perfectly coordinated course of study with a single textbook series might not be ideal. We in the USA are not in danger of getting that much articulation and uniformity, but we may be in danger of putting too many hopes in that direction. Almost no place did we hear that there is a problem because students cannot go from one set of text materials to another. The complexities of sequencing are many, such as in the ALTE elementary school social studies program, where a curriculum committee chairperson told us:

> *As can be seen by comparison of the Social Studies Committee's Chart and School A's chart, that school is using one of the recommended programs at every grade level [Allyn and Bacon: kindergarten, 1; Holt: grades 2,3,4, and 6; MACOS: grade 5]. There appears to be no problem in organization or sequencing (p 3:32).*

In this suburban midwestern site we did not find a strong pleading for better articulation, vertically or horizontally. The high scholastic-aptitude children, as all children, had not learned all that their teachers felt they should, but as they entered

a new grade they learned what they needed so quickly that it did not become an issue. The three prime subject matters in the high school, science, math and history had in fact been greatly articulated with sequential prerequisites.

In this site, there was perhaps extra pressure on the teacher to be a "strong teacher." This meant knowing the subject matter, knowing how to teach it to particular groups, being highly motivated, engaging the students and having a strong personality. The pressure was on the teacher to do better on tests oriented to college admissions, not on basic skills tests--so the teacher martialled his/her efforts at being collegiate and individualistic--and not spending very much time on what some are calling the "minimum competencies."

Lou Smith, our observer there, found that the objectives teachers pursued in this program were identified in terms of student excellence rather than minimum competence--and the difference was much more than two separate points on a scale.

> One cannot be around the ALTE District very long without running into comments about "academic excellence." As a value, purpose, goal, objective, it provides a perspective on the entire system, yet at the same time, it harbors some interesting implications. It doesn't sound like or carry the usual connotations of, the language of behavioral objectives that the educational psychologists and learning theorists are fond of citing. Nor does it convey the flavor of the management-by-objectives school of thought in educational administration. Rather it seems a mix, a corruption perhaps, of a humanistic stance of "knowledge for its own sake" and "learning as a social mechanism." (p 3:40)

But such was the exception.

COMPETENCY-BASED EDUCATION

In almost all the other CSSE sites there has been an effort to redefine the curriculum in terms of student "competencies." As indicated in the previous chapter, it was only recently that the aims of schools were expressed in terms of abilities and competence. The language of goals has depended on who has been doing the talking. The philosophers have their language, the employers theirs, the teachers theirs, the liberal arts professors theirs. These goals now are in the languages of the behavioral psychologists or psychometricians, who speak of tasks to be accomplished and traits to be developed. They have emphasized that it is useful to talk that way because such things can be measured, tested. They sometimes acknowledge that the objectives can get changed in the transformation from one language to another, but often for the better, and that it is the operationalization of student behaviors that permits us to develop a technology of education.

To be sure, there have been emphases on performance, on testing, on skills, on tasks, since early times. Comenius, Pestalozzi and Herbart thought along those lines.

What is often considered the first educational research study was a study of spelling skills.* Just after World War II the National Council for the Teaching of Mathematics advocated expansion of curricula for all children to include twenty-nine specific "competencies." The programmed instruction movement featured individually-paced questions designed to gradually strengthen the habits needed by a learner to respond with particular answers to particular questions. The orientation to student competence has long been a part of teaching, but only recently has it been a nationwide conceptual base for organizing the curriculum.

Among the things that are being emphasized as competencies are: reading, arithmetical computation, map-reading, placing a mail order for merchandise, recognition of correct word associations and grammatical constructions. Among the things not included are: writing composition, constructing an argument, making a proof, listening with comprehension, oral discourse, and complex knowledge in all academic disciplines. The idea is strong in the country today that youngsters are so poor at the basic skills that they should devote almost all their attention to getting ready to learn the important things.

It is felt by some that employers are not hiring young people because they are not sufficiently competent. In an Associated Press story (early November, 1977) by staff writer Martin Crutsinger, Florida State Education Commissioner Ralph Turlington was quoted as saying:

> *I tell 11th graders that they are lucky [to be taking these new tests]. For the first time, they will be able to show a prospective employer a diploma that is proof they can read and do arithmetic. What is included in the test are things we all need to be able to do in our every day lives.*

Our CSSE studies across the country have uncovered no evidence that employers want such information from the graduate. They already have better ways of finding out how suitable the youngster is for the work they have. This is not to say that the employers are indifferent to the quality of education youngsters get in school. (For the most part, youngsters are better educated than needed for many of the jobs open to them, e.g., supermarket baggers, parking lot attendants, life guards. The difficulty youngsters have getting jobs is much more because principal wage-earners are "moonlighting" and still more housewives are competing for jobs, trying to make ends meet--not because the youngsters lack the education to do the work.)

The assessment tests in Florida and elsewhere are not directed at the things that people do in their everyday lives any more than the previous school lessons were. These tests have not been validated as measures of education nor as bases for diagnosing individual or district-wide learning problems. They have been built upon a carefully gathered set of intuitions, shaped by test developers and committees of educators

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*J.M. Rice, "The futility of the spelling grind," Forum 23 (1897): 163-72. and 409-19.

and lay people. There seems little reason to expect more from the newer editions than we have been getting from the National Assessment of Educational Progress and earlier state assessment batteries, such as the Michigan Assessment Tests,* which have few supporters other than their sponsors.

As best we can tell, the two reasons we have "competencies" and "performance tests" now appear to be to provide teachers with a more concrete and limited set of obligations and to provide administrators with concrete information about student learning. Teachers have had in the past and will continue to have ample and higher quality information about student learning, but it is partly tacit knowledge, informally gathered, and they cannot share it effectively with school officials and the public. Now, with a transformation of school responsibility toward the development of competence, both reasons look good and circumstances appear amenable to using instructional technology. But whether or not the management information can be put to good use remains a question. Poor learning and poor teaching will probably continue to be a problem where it has been a problem in the past.

Yet enthusiam for competency based education and proficiency testing seems to grow. In ARCHIPOLIS

> the district science supervisor lamented the steady deemphasis of academic subject matter in recent years, . . .but he felt "it had bottomed out." Now he was optimistic that the Competency-Based Instructional Program would regenerate support for science, math, and social science.

And in San Francisco late in 1977 HEW Secretary Joseph A. Califano, Jr. said:

> *In short, basic competency tests, used skillfully and sensitively, are useful and necessary. They are a limited, but very important tool for charting and improving the process of education. We need to do more testing and we need to do better testing.*

In our visits to eleven districts around the country we found considerable evidence of "more testing" but, except for personnel in charge of testing, we found few to testify that testing was useful to them and no knowledge of any district or school which had substantially improved its educational system by moving to a competency based educational program.

Hierarchies of Learning. One of the attractive features of a task analytic or competency-based approach to instruction is that certain skills and tasks become obviously prerequisite to others. In order to do long division it is necessary to

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*See Ernest R. House, Wendell Rivers, and Daniel L. Stufflebeam, "An Assessment of the Michigan Accountability System," Phi Delta Kappan, 55 (June 1974): 663-669; and Jerome T. Murphy, and David K. Cohen, "Accountability in Education: The Michigan Experience," The Public Interest, No. 36, (Summer 1974): 53-81.

subtract; in order to understand the Civil War it is necessary to understand the geography of the Atlantic seaboard; in order to teach PSSC it is necessary to check out math skills:

> Paul indicated that sophomore science instructors were asked to recommend students, but he noted, "Actually, James and I are more concerned about math competency than about their references . . . (VORTEX, p 10:9)

The task of curriculum development and teaching, then, is one of identifying the most important foundational skills and building upon them. As anthropologist Jacquie Hill-Burnett observed in ARCHIPOLIS (p 9:5.,

> Many, but not all, junior high school social studies and most senior high school social studies teachers regard reading skill as necessarily prior to learning social studies.

But elementary teachers there challenged the notion that reading skill should be fully developed before introducing substantive learnings. Dr. Hill-Burnett quoted them as saying:

> *. . . teaching children to read is a never-ending process. Children don't just learn to read for all subjects for all times (p 9:5.)*

and found them dismayed at high school teachers who seldom seemed to work at teaching youngsters to read new content areas.*

As we listened to and read the formal rhetoric of the school about the essentiality of reading and other readiness skills we wondered if teachers would tend to postpone analysis and interpretation of ideas right out of the school curriculum. We were reassured somewhat by the responses to a survey question asking about whether it is best to teach reading skills and math facts alone at first, along with lots of basic information, or even at the same time teaching analysis and interpretation. The model response for elementary school principals and social studies supervisors was to teach all those things together, though high school math teachers overwhelmingly said, "Teach the basic reading and math at first, the other things later." (For a more complete display of the results see Item U10 of Scenario U in Chapter 18,)

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*In a presentation at the Annual Meeting of the National Council of Social Studies in November 1964, a member of the Johns Hopkins University project staff engaged in a study of American high schools suggested that "both a ceiling and a floor" were present in secondary school expectations. "If the pupil cannot read at a certain level by ninth grade, there will be little 'outreach' assistance extended to him," the researcher declared, "because high school instructors assume a basic reading competency exists. On the other hand," he continued, "outstanding students usually encounter a top-level or ceiling effect beyond which their efforts cannot take them."

One is reminded of a recent warning by John C. Glidewell that "education for contemporary life may require more deviancy than schools can tolerate," in "New Psychosocial Competence, Social Change and Tension Management," 104, in Research Contributions from Psychology to Community Mental Health, Jerry W. Carter, Jr. ed. (New York: Behavioral Publications Inc., 1968).

The criticality of learning sequences has been alluded to also in a previous section. There is little agreement at present as to the advantage of one sequence over another, and even as to the general organizational value of a hierarchical approach. An obvious risk is that too much emphasis will be given to mastering general skills, delaying too long the study of systemic content such as "homeostatic life-sustaining systems" and "demographic changes related to land-use."

> As part of our CSSE national survey we asked junior high school teachers:
>
> Please indicate whether you agree or disagree with the following statements:
>
> > What students must learn first when they begin to study science is vocabulary. They do not at first need to understand the reasons scientists study this and not that--nor the reasons scientists use this method and not that method. The learner of science must go through stages--first the language, second the concepts, then the scientific method, and finally an appreciation develops.

Among the comments from teachers who agreed were:

> *I strongly agree. The vast majority of my students know very little scientific language and are not really capable of understanding most concepts until their related vocabulary words are first covered.*
> *(a South Carolina sixth grade teacher)*
>
> *A view to methodology is important from the outset although the focus is not there to begin with. The student should have some "hints" as to the association between vocabulary and method.*
> *(a Missouri teacher of Afro-History & Psychology)*

and among the comments from teachers who disagreed were:

> *I do not think anyone learns in "stages" as teachers plan them. We know human beings mature at different rates with certain kinds of mental activities becoming possible at different age ranges, but it seems silly to speak of learning language, then concepts, then method. Science, any kind of systematic thinking, is hard to break down into L-C-M stages. Concepts, the mental images we develop, grow with experience--usually best with the most concrete experiences--so our goal must be to facilitate concept formation. The major concept we should build is "science"--what it is--that "art of science" should be the subject of our teaching--language, concepts, and methods from the start.*
> *(a New York 9th grade sociology teacher)*
>
> *Students should learn the way of scientists by the discovery method, experimenting and learning vocabulary along with experimentation. To learn the way of the scientist the students should experience the ways of scientific discovery in the classroom.*
> *(a New Jersey teacher of grades 6, 7,& 8)*

Too few of the 75 teachers sampled responded to justify presenting a tally.

Mastery Learning.* Another part of the technologizing of instruction is the prespecification of the degree of mastery of a task to be assured before passing to a subsequent learning task. Among many instructional technologists is the belief that a general figure can be set, such as 95% mastery for individualized instruction or 90% mastery for 90% of the students for group instruction. In many places we found teachers referring to these standards as logical and desirable, but except with the packaged instructional systems we found few instances of teachers working with the mastery concept. (We did recall the research of Ulf Lundgren of Sweden who found teachers informally and even unconsciously attending to a "steering group" of students at about the first quartile to get information as to when to review further and when to pass on to another study-unit.)

In RIVER ACRES (p 1:78)

> The district [has just] initiated a minimum competence check in reading comprehension and mathematics for its seniors in response to Texas regulations.

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*Benjamin S. Bloom has voiced and illustrated the Bruner-Skinner paean that every child can learn anything, only differing in time-to-learn. Under the label of mastery learning, he has claimed that if tasks are appropriately specified and feedback rigorously obtained, the differences between students in time-to-learn can be reduced sufficiently to justify the school's setting common requirements or "minimum proficiencies" for all learners, and can further sustain the teaching long enough to increase retention to a point that would justify the label "mastery." Bloom has stressed the use of formative evaluation testing (his definition, not Scriven's) to catch student performance errors before they can be compounded.

It is apparent that a mastery learning approach will be most adaptable to instructional tasks that are widely useful, that lend themselves to specification and testing, in a classroom where the uniqueness of personal understanding and those learnings that come with high-above-minimum proficiency (implications, nuances, further relationships, probably including the comprehension of many of the more difficult science concepts) are to be given lower priority. These "mastery learning conditions" are attractive to many people seeking a greater emphasis on basic skills and knowledge. (See Benjamin S. Bloom, "Introduction to Mastery Learning and Theory," edited by James H. Block, Schools, Society, and Mastery Learning, New York: Holt, Rinehart and Winston, Inc., 1974. For critiques of mastery learning see the chapters by James Block and William G. Spady in the same volume.)

We wanted to compare several perceived needs for improvement of curricular programs in the schools. So we asked three groups of professional educators to indicate the attention needed in the present curriculum in your school:

	Needs more attention	Needs less attention	Amount of attention about right
Teaching of "prerequisite skills"	___	___	___
Specification of course objectives	___	___	___
Emphasis on abstract concepts, ideas	___	___	___
Emphasis on facts, rules, techniques	___	___	___
Setting minimum proficiency levels	___	___	___

Scoring each response +100 for "needs more attention," -100 for "needs less attention," and 0 for "amount of attention about right" we got scale values* as follows:

	from 55 Elementary School Principals	from 145 Gr. 7-12 Social Studies Supervisors	from 94 Gr. 10-12 Math Teachers
Teaching of "prerequisite skills"	+24	+66	+75
Specification of course objectives	+29	+53	+11
Emphasis on abstract concepts, ideas	+18	+18	+17
Emphasis on facts, rules, techniques	+10	+ 2	+30
Setting minimum proficiency levels	+36	+66	+77

It is clear that all of the three groups felt that setting minimum proficiency levels is one of the more important things to do in improving the curriculum. Unfortunately the groups indicated that all five things need more rather than less attention--which is difficult to do in an already busy classroom.

We noted earlier that one way of setting minimum scores is in terms of minimum proficiency for high school graduation. In the past school was usually seen as providing an opportunity to take courses. A student learned various things there. The teachers really did not know what all they learned, and what they would remember, and how it would influence them. They knew pretty well who the good students and the poor students were. They sometimes had to write references to employers or college admissions offices, and in a more or less confidential way, they spoke of a youngster's competence. But they did not make public acknowledgement of a student's inability or disinterest in schooling, by withholding a diploma.

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*These scale values are theoretical medians. If all respondents had said "needs more attention" the scale value would be +100. If all said "needs less attention" the scale value would be -100. A scale value near zero means that the numbers saying "needs more" and "needs less" are about the same.

Passing from grade to grade was considered automatic, a "social promotion," not acknowledgement of competence. Awarding the diploma was also a social promotion.

Although the high school diploma has not (at least in this century) been a certificate of merit, various citizens, elected officials and educators, in their dismay about the incompetence of some graduates have implied it has been. Nevertheless, there may be merit in their proposal to have a proficiency diploma, perhaps authenticated successful test performance, such as a seventy percent correct response on the Functional Literacy Test developed by the State of Florida. Admiral Hyman Rickover and a few others have advocated a national testing as a basis for awarding the high school diploma.

We found relatively little interest in this matter in the eleven districts we visited. In VORTEX and URBANVILLE there were examinations that had to be passed prior to graduation but one had several opportunities to pass the test, and remedial courses if needed.

To check on the concerns about high school graduation requirements more broadly across the country we asked our survey respondents two questions, one general and one specific to science competency.

Should all high school students in the United States be required to pass a standard examination in order to get a high school diploma?
___Yes, they should ___No, they should not ___I don't know

	Large City >100,000		Large Suburban		Non-Metro <100,000		TOTAL		Number Responding
	Yes	No	Yes	No	Yes	No	Yes	No	
___ Teachers	75%	10%	58%	31%	61%	22%	66%	19%	172
___ Curric Supr's	86%	9%	48%	21%	38%	53%	56%	36%	219
___ Administrators	33%	16%	6%	94%	34%	45%	42%	40%	74
___ Students	53%	33%	38%	40%	78%	17%	54%	33%	241
___ Parents	55%	45%	18%	79%	79%	17%	69%	27%	124

Should school districts require some minimum competency level in science for all students to attain in order to graduate from high school?
___Yes, they should ___No, they should not ___I don't know

	West Yes	West No	Midwest Yes	Midwest No	South Yes	South No	Northeast Yes	Northeast No	TOTAL Yes	TOTAL No	Number Responding
___ Teachers	94%	4%	41%	36%	59%	17%	80%	6%	67%	17%	170
___ Curric Supr's	52%	42%	47%	39%	77%	18%	87%	10%	70%	23%	223
___ Administrators	50%	15%	27%	34%	52%	35%	4%	96%	37%	37%	73
___ Students	51%	40%	26%	64%	50%	32%	60%	35%	46%	40%	236
___ Parents	57%	29%	59%	40%	68%	25%	64%	35%	67%	30%	123

Standard errors are not available for these percents.

Our results were not unlike those of George Gallup who found among citizens 65% favoring such a requirement for graduation.*

In summary, with regard to pluralism and uniformity, across the country, in school and out, we found a concern about teaching and learning. The pluralism of our communities seemed to hold back teaching and learning. Making the curriculum more uniform seemed to be a way to go.

We noted particularly a considerable difference between the national concern and the local concern. The national concerns are expressed in the popular press--it tells of test score archives, poor reading and writing, suits filed by non-reading graduates, hostility and misconduct in classrooms, problems with busing, etc. The problems seen locally are less sensational, more pervasive. In talking with teachers, students and parents one hears about bored students; absenteeism; parents who support the student rather than the teacher, or don't support either one; poor reading and writing, uniformity and articulation, overly large classes, heterogeneous classes, and so on. The problems are related and overlap, but a direct attack on the national problems seems not too likely to help the individual teacher who has trouble teaching a heterogeneous class and the individual learner who has trouble learning those things now being designated as "essential."

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*George H. Gallup, "Eighth Annual Gallup Poll of the Public's Attitudes Toward the Public Schools," Phi Delta Kappan 58 (Oct. 1976): 199.